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ISBN 0-315-30314-X

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(SIGNED) K.E. Robinson

PERMANENT ADDRESS:

4, 9529 - 87 Ave

Edmonton, Alberta

T6C 1K4

DATED April 16 1986

THE UNIVERSITY OF ALBERTA

The Selection and Implementation of an Information System

by

© Karen Elizabeth Robinson

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Education

Department of Educational Administration

EDMONTON, ALBERTA

Spring, 1986

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled The Selection and Implementation of an Information System submitted by Karen Elizabeth Robinson in partial fulfilment of the requirements for the degree of Master of Education.

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Supervisor

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.....

Date. April 16, 1986

Abstract

This study was designed to assist the staff of the Edmonton Regional Office of Education with the selection and implementation of a computerized information system. In addition, the underlying objective was to observe the interrelationship of need, technology, and the change process with respect to the implementation of this system.

To address the first objective, the information needs of the regional office staff were identified, a solution was selected, and a system was developed and implemented. To address the second objective, the responses, attitudes, and reactions of the users to an information system were recorded and observed. In other words, an innovation was implemented, and an indepth assessment was conducted to discover and understand the complexities of this phenomenon.

In addition to identifying the interrelationship of need, technology, and change, the research revealed the significance of the human dimension and ways in which initiators of change can use the change process to guide their actions. Within the context of this study, the perceived need for a change and the availability of technically feasible alternatives were significant variables, but these factors alone did not constitute a process. Change theory was the process, and need and technology were factors within that process. As a process, change theory provides a framework for organizing and itemizing the factors which influence the successful implementation of an innovation. Using these factors as a guide, agents of change can guide and direct the people involved in an innovation through a series of events designed to help them understand why, when, and how a change will occur.

Acknowledgements

For the opportunity of education;

For the comraderie of classmates;

For the inspiration of teachers;

For the ecouragement of family;

For the cooperation of study participants;

For the guidance of my committee;

For the love of Lance;

I give thanks.

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Chapter I

Introduction

A. Theoretical Perspective

In his book **Megatrends** released in 1982, John Naisbitt postulated that society has undergone a subtle, yet explosive shift from an industrial based society to an information based society. "In an industrial society, the strategic resource is capital ... But in our new society, the *strategic* resource is information. Not the only resource, but the most important" (Naisbitt, 1984: 6). Therefore, it is not surprising that the management of information (i.e., the collection, control, organization, and dissemination) has taken on new importance. Information systems are considered to be crucial to the operation of any business. Again and again statements like "information management is not new; it is just becoming more important" (Zimmerman, 1984: 33) are reiterated. For example, a recent edition of the Globe and Mail devoted an entire section to the topic and featured such articles as one entitled "More Firms Recognize the Importance of Data Management" (Globe and Mail, p. C11, Nov. 21, 1985).

The advancements in computer technology have provided a method of meeting the increasing demands for information management. Not only is computer technology more accessible to people, but also it is becoming easier to use and more powerful. As a result, new technologies are not simply providing an electronic means of processing information, they are revolutionizing the past methods of information management (Martin, 1982, 1984). The methods of developing, using, and managing information systems are both new and improved. The new methods include fourth generation languages, prototyping, and personal computers.

The solution for the management of information would appear to be simple; select the appropriate new methodology and implement it. However, these new methods represent widespread changes for people within an organization, both the developers and the users of information systems. As a result, it is essential to consider the implementation of an

information system and information management methodologies within the context of the three phases of the change process: adoption, implementation, and continuation. Knowing what should be implemented and successfully implementing the solution are two distinct problems. Success depends on people as well as technical feasibility. Innovators "have to combine some expertise and knowledge about the direction and nature of change with an understanding of and an ability to deal with the factors in action which characterize the process of adoption and implementation" (Fullan, 1982: 84).

In summary, the three factors which drive the management of information are need, technology, and change. The information age necessitates better access to information systems, technology makes such systems possible, and change theory guides the implementation. The case study that follows provides a vehicle for examining and observing each of these three factors and demonstrating how they are interrelated.

B. Background

Alberta Education is a department within the provincial government of Alberta. It is responsible for providing, administering, and financing the education of children throughout the province from Kindergarten to grade 12. Internally, the department is divided into four divisions and 32 branches. (Refer to the organizational chart, Figure 1.1.) Most of these branches are located in Edmonton in the Devonian Building. This building is also referred to as the Provincial Office of Education. Five of these branches, also known as regional offices, are located in Grande Prairie, Lethbridge, Red Deer, Calgary, and Edmonton. For administrative purposes, the province is divided into six zones and the responsibility for these zones is divided among the regional offices.

Although the number of staff in each regional office varies, each has a director, an associate director or directors, consultants, and support staff. For example, the Edmonton Regional Office of Education (EROE) has a staff of 40: one director, three associate directors, twenty-three consultants, and thirteen support staff. Prior to 1984, the major functions of the

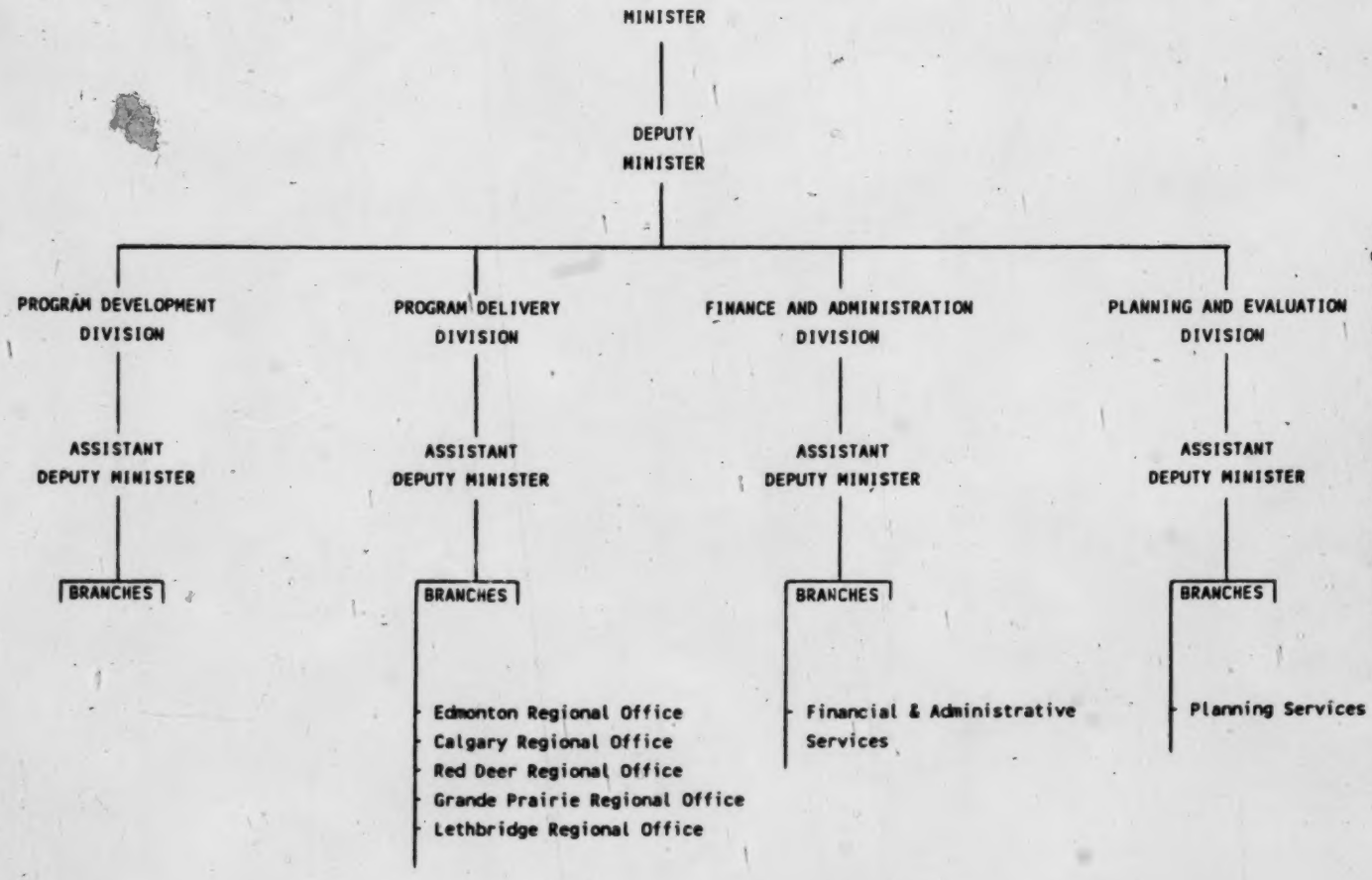


Figure 1.1

Organizational Chart: Alberta Education

regional offices were to provide consulting services, and to conduct school evaluations for school jurisdictions within the zones for which they were responsible.

Management and Finance Plan

In the spring of 1984, the funding process for education in Alberta was reorganized through the introduction of the Management and Finance Plan (MFP).

> [This plan] provided a completely new approach to funding education in the province. The plan placed primary emphasis on the development of policies to guide the education of children. The role of Alberta Education shifted to monitoring the results achieved within school jurisdictions. A new set of provincial evaluation policies was an integral part of the plan. The policies ensured that students, teachers, programs, schools, and school systems were evaluated on a regular basis (Alberta Education, Seventy-Ninth Annual Report, 1983-84: 7).

This new approach changed both the structure of payments and the method of approval. First, although the the largest portion of the grants was paid out on a per pupil basis as in the past, additional funds for special programs were calculated according to specific formulae on a grant by grant basis. Second, the approval procedures changed from a completely centralized system to a partially decentralized system. Previously, the only people who could approve funds were those within the Finance and Administration Division of the provincial office. Although most of the responsibility remained there, some of the special needs grants became the responsibility of Expenditure Officers within the regional offices, and all of the special needs grants had to be verified by Performance Certifiers within the regional offices.

Among other things, the Management and Finance Plan sought:

> to increase the accountability of both Alberta Education and school jurisdictions to the electorate, and increase the efficiency and effectiveness in the use of limited public funds for the provision of education with the focus on providing benefits directly to students (Alberta Education, MFP manual, 1984: 5).

The plan had three phases: planning and development, program delivery and monitoring, and the management of results. The second phase had an immediate impact on the regional offices because it imposed a new role regarding funding and control. The second phase gave the following responsibilities to the regional offices:

1. verification of the Grants Application Forms, to ensure that the jurisdiction's

Education Plan and the programs for which the grants are requested, are in place,
2. delivery of programs at the local level, and
3. monitoring of programs delivered at the local level by Alberta Education and the school jurisdiction (MFP manual, 1984: 39).

To accomplish these tasks, regional office personnel were appointed Performance Certifiers and Expenditure Officers. Performance Certifiers were responsible for one or two grants. They reviewed each form as it was submitted, and verified that the form was correct and complete. Once verified, the grant forms were passed on to the Expenditure Officer who signed the forms, and forwarded them to the Grants Administration Branch, Finance and Administration Division.

Inherent in this shift in responsibilities was a shift in information requirements. Administrators within the regional offices were faced with new decisions and as a result, had a need for new information to support these decisions.

C. Problem

"Decision-making is a major responsibility of all administrators. It is the process by which decisions are not only arrived at, but implemented" (Hoy and Miskel, 1982: 264). The senior administrators in the EROE were no exception. To facilitate the decision-making process, they required current, reliable information. Access to information was necessary to provide them with the ability to deal more effectively with the decision-making process.

How can an administrator obtain the required information? A data base can be the first step. Whether it is electronic or manual, simple or complex, a data base is a collection of facts arranged and defined according to predefined conventions. However, it is only through the manipulation and organization of these data that information is produced. The framework which defines the procedures and rules for the addition, storage, maintenance, and sorting of data is called a data base management system (DBMS). Although a DBMS can be simple and manual, manual solutions are seldom appropriate in a modern office environment. A computerized DBMS is essential. When designed correctly, these systems can provide the required information. Once generated, this information can be disseminated to appropriate

decision-makers.

Due to the implementation of the Management and Finance Plan, new and increased informational needs were emerging. The administrative staff at the Edmonton Regional Office of Education (EROE) recognized the need for a better system to assist them with the organization of data. The previous manual record keeping and tracking systems no longer provided the information necessary to fulfill the new functions required by MFP. A need for an effective information system was clear.

However, the realization that an information system was needed was only the first step. It was also necessary to select and implement a solution. Specifically, it was necessary for the administrative staff at the EROE to clarify their needs, investigate alternatives, establish selection criteria, choose a solution, develop an implementation plan, and implement the solution. In other words, a problem had to be solved, and a change was required. This study was designed to outline a plan designed to accomplish thesesteps. In addition, the services of an externalconsultant were also provided to assist the EROE administrative staff in conducting the plan.

As a whole, this study provided a vehicle for observing an innovation. That is, it provided the framework in which to examine the process of change. Specifically, the study had the following purposes:

1. to determine the information needs of the EROE,
2. to design an information system to meet those needs,
3. to develop two parallel information systems: one on a mainframe computer and one on a microcomputer,
4. to compare and evaluate the capabilities and/or limitations of the two systems,
5. to observe and assess the attitudes and reactions of the users towards an innovation, and
6. to identify factors which influenced the adoption and implementation phases of the change process.

Definitions

The following terms have a specific meaning within the context of Alberta Education. They are defined here and used throughout the study. They are listed in logical rather than alphabetical order. Additional technical terms, related to information systems, are defined as they are used, and have been collected in the Glossary, Appendix A, for the reader's convenience.

Management and Finance Plan (MFP): A plan developed by Alberta Education to provide a completely new approach to funding education in the province of Alberta. The plan placed primary emphasis on the development of policies to guide the education of children. The role of Alberta Education shifted to monitoring the results achieved within school jurisdictions. A new set of provincial evaluation policies was an integral part of the plan. The policies ensured that students, teachers, programs, schools, and school systems were evaluated on a regular basis

Program: A program consists of interdependent activities and services designed to achieve specific organizational goals, policies, and objectives. These programs are divided into four groups: Special Needs Programs, School Capital Programs, Transportation and Boarding Grants, and Provincial Evaluation Policies. Examples of programs are curricula, Vocational Education, Counselling and Transportation.

Special Needs Program: A subset of all programs, this group consists of eight programs: Early Childhood Services, Educational Opportunity Fund, Official and Other Languages, Regional Film Centres, School Extension Programs, Special Education, Teacher Inservice, and Vocational Education.

Performance Certifier: A person within the regional office who is designated to certify, monitor, review, and report on one or more of the Special Needs Programs. This person is a consultant and usually has expertise in the area of the Special Need.

Expenditure Officer: A person who has the authority to authorize the disbursement of payment for a particular program.

Grant Application Form: The form used by a school jurisdiction to apply for funds for a particular program. Each program has a different grant application form.

Form A: This form certifies that the courses listed are being offered, that the teachers teaching are qualified and hold valid teaching certificates, and that the required amount of time is devoted to instruction in the subjects offered. It must be sumitted to Alberta Education by each Senior and Junior High Schools in the province. The form must be signed by the principal, superintendent, and appropriate regional office director.

Form B: This form indicates the number of students enrolled by grade level, and lists the teachers' names. It is submitted to Alberta Education by each elementary school in the province. Unlike the Form A, however, this form is not a legal document, and Alberta Education has no recourse if it is not submitted.

Delimitations

The scope of the study was delimited in the following ways.

1. MFP was identified as the focus; therefore, the study assessed and addressed the informational needs percipitated by MFP. Twenty-one forms were identified as pertinent: Form A, Form B, and the nineteen Special Needs Program Forms. This delimitation also reduced the number of data elements, and made the design and construction of the system more easily attainable.
2. The information system that was developed was a pilot system. It was not used as a full production system. Therefore, the researcher could only project the performance of the final information system, and it was not possible to comment on the continuation phase of the change process.

Limitations

It was not possible to purchase software or hardware for this study. Instead, the researcher investigated data base management software and associated hardware which were

available within the government of Alberta. From among the alternatives available, a software product called FOCUS and its microcomputer version PC/FOCUS[1] were selected. Although it is undeniable that availability was a key selection criterion, there were other reasons why FOCUS was chosen.

1. The computer services department of the government had perviously selected FOCUS after a thorough evaluation of similar products.
2. Documentation indicated that the microcomputer version (PC/FOCUS) could meet the identified needs of the EROE.
3. By using two versions of the same software, the researcher did not have to learn two completely different products with different commands and command structures.
4. The matched pair also enabled the researcher to experiment with the transfer of files from the mainframe to the microcomputer and vice versa.
5. Various authors (Howitt, 1984; Kallenbach, 1984; Martin, 1984; McMullen and McMullen, 1984) recommended FOCUS. (The specific capabilities and features of FOCUS are explained in the Appendix B.)
6. It was not possible for the EROE staff to use and experiment with the information system in their own office because the necessary hardware was not available. Instead, arrangements were made for the staff to use the information system on hardware in the provincial office.

D. Overview of the Study

Chapter Two presents an overview of the literature in the area of information management and change. The methodology is described in detail in Chapter Three. Chapter Four recounts and synthesizes the results. Chapter Five interprets the results, and concludes by outlining recommendations and conclusions based on the results presented in Chapter Four.

---

[1] PC is the abbreviation for "personal computer," another name for a microcomputer. Therefore, the term PC/FOCUS means the version of FOCUS which runs on a personal computer (or microcomputer).

Chapter II

The Context

This chapter presents a review of the literature regarding information systems and their implementation. This discussion provides the underlying theory for this study. In particular, the following topics are covered:

1. the meaning, capabilities, and evolution of information systems;
2. educational applications of information systems;
3. the development cycle;
4. fourth generation languages;
5. choosing a fourth generation language;
6. the change process; and
7. the implications of these readings.

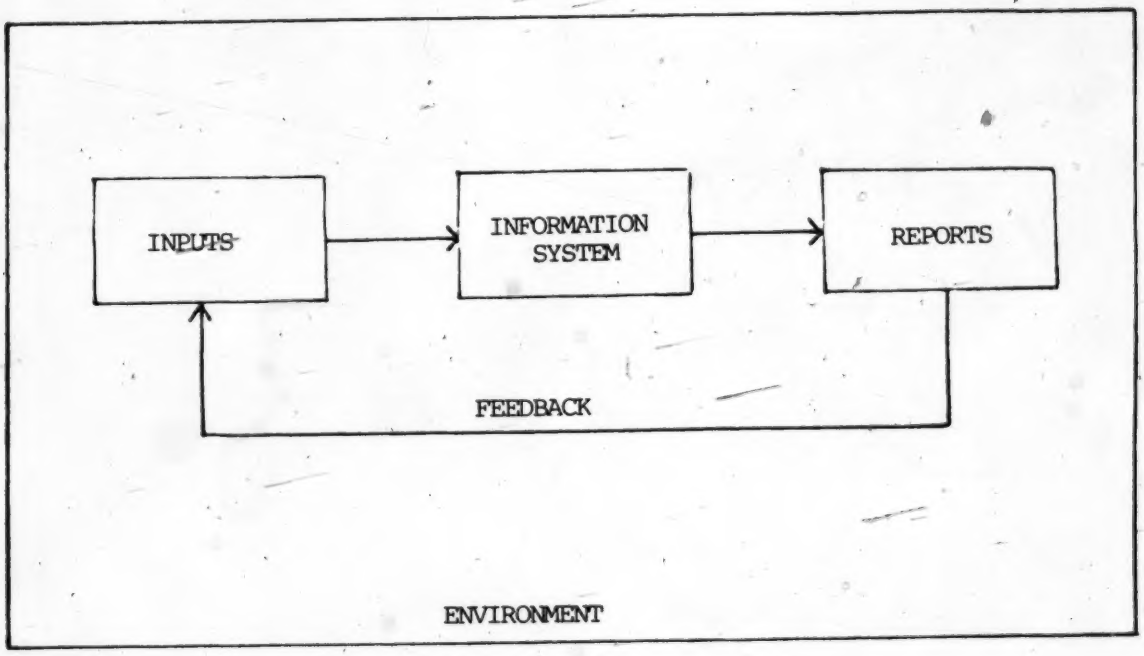
A. Information Systems

Information is a product. Like any other product, it is produced from raw materials or inputs using a specific process. In the case of information the inputs are data, the processes are information systems, and the outputs are reports. Each will be explained in more detail below.

Although an information system, itself, is not a social system, it exists within one as illustrated in Figure 2.1. Therefore, as well as the tangible, predictable components such as data elements (inputs) and software products, there are the intangible, unpredictable components associated with the environment such as user expertise and user resistance. These factors make up the human dimension. The way people respond to change will be discussed in the latter part of this chapter.

Figure 2.1

Information System Components



The Input

Information is produced from data. A collection of data is a data base. In a computerized data base, data are stored in machine readable form according to predefined conventions (Hussain and Hussain, 1981). Although the data or data elements are the foundation of the data base, they are meaningless in themselves. When an output, a report, is generated, meaning is attached to the data; the data have become information. Information is generated when the data are organized or manipulated according to specific rules so that the required information is produced. Raw data can also be used to derive or calculate new data elements. For example, an employee's gross salary can be calculated by multiplying two data elements: rate of pay and hours worked. The data element gross salary is not stored in the data base. Instead, it is derived at the time the report is requested. The important thing to note, however, is that the calculation of gross salary is only possible if the required elements are present.

The Process

This is the pivotal component. A process is "a systematic sequence of operations to produce a specified result" (Hussain and Hussain, 1981:581). In the realm of information, the process is the information system or data base management system (DBMS), itself. A DBMS defines the ways in which the data are used to produce the required information. Technically, a data base management system "is the software, used in conjunction with application programs, that generates, operates, and maintains the database" (Robinson, 1981:44). That is, the functions, characteristics, and capabilities of a particular DBMS are defined by and limited to the quality of the software used. As a result, not all information systems are the same, nor should they be. They have different characteristics, users, uses, and labels. These are explained below.

The first term used to describe computer systems which produced information was Electronic Data Processing (EDP). Also referred to as Data Processing (DP), it has also

become synonymous with computer processing or simply the use of computers in large organizations. For example, computer departments within an organization may be referred to as DP or Computing Services, and the majority of the work they do is related to the processing of data. EDP is the first phase of data base management.

> 'Classical data processing' is data-oriented and tends toward batch processing with printed output reports. It addresses clerical functions and its success is measured in transaction volume and clerical costs. It deals with structured, repetitive problems like paying an employee on time, accurately, and reliably. The source of the information is typically internal to the business. ...The focus of the system is efficient processing, and the primary goal is to produce the output report with the highest degree of accuracy and control at the least cost (Vierck, 1981:37).

The main users of these data tend to be supervisory personnel; the people concerned with the operations level of the organization.

The next information system phase was Management Information Systems (MIS). "The field of management information systems has as its central concern the effective design, implementation, and use of computer-based systems in organizations" (Markus and Robey, 1983: 203).

> The MIS no longer addresses strictly clerical processes but rather focuses on business operations. ...The features of an MIS system include online input, inquiry, and exception reports. The MIS addresses decision making and problem solving, but they are structured problems using internal data sources (Vierck, 1981:37).

These systems provide middle managers with the information necessary to make decisions about implementation, or formulate tactical plans from which to operate.

The next information system phase was Decision Support Systems (DSS). A

> DSS system is oriented to the decision maker. Its focus is decision making and its orientation is ***improving the effectiveness of the decision making process in the organization***. ... DSS features include help for unstructured problems and the use of external data sources (Vierck, 1981:37).

The system is also interactive and flexible. DSS "support, rather than replace, judgement in that they do not automate the decision process nor impose a sequence of analysis on the user" (Keen, 1981:1). The major users of these systems are top managers and strategic planners. They use DSS to improve the quality of their decisions by building models such as population projections, and financial simulation models.

The capabilities of information systems have evolved from DP to MIS to DSS. Each new development has not replaced the other; instead, each has enhanced the capabilities of the former, and expanded the user base. Although there are no true dividing lines and overlaps exist, top managers are the major users of DSS, middle managers are the major users of MIS, and supervisory personnel are the major users of DP. Figure 2.2 illustrates the users of these systems according to their organizational level. The diagram also illustrates the major source of data for each, and the variation from structured to unstructured problems. By graphically depicting the characteristics of each system, it is easier to understand the reasons why one level of user would prefer and use one type of system over another. Top managers make ad hoc decisions. Their problems are generally unstructured and often require external data sources. On the other hand, supervisors usually require information which is routine and repetitive; therefore, a structured system using internal data sources is suitable. The needs of the users are as diverse as the characteristics of the information systems, themselves.

Should a new enhancement - a bigger and better information system - be anticipated in the future? Will a model system evolve which meets the needs of all users regardless of their organizational level? Rather than this cycle continuing, the review of the review of the literature suggests a new approach for DBMS called information resource management (IRM) or data resource management (DRM). It is defined as "a management function to develop and implement policies, programs, guidelines to plan for, manage, and control information and information resources" (Vierck, 1981:43). This is a global organizational perspective. Data are viewed as a resource which require effective management, the same as other resources. The task for the information resource manager is to coordinate, understand, and organize all aspects of information management. However, the successful transition to the global perspective of IRM is dependent on another factor. Top management, beginning with the chief executive officer (CEO), must support this approach. IRM must be considered as important as the finance or marketing departments. Therefore, the manager should be a senior executive with the authority to enforce the policy and procedures necessary to manage all aspects of

NOTICE

The material contained on this page was removed because the copyright permission was unavailable. This page contained a three dimensional diagram which graphically depicted the characteristics of information systems with regard to types of users, data sources, and organizational level.

ORIGINAL SOURCE

Vierk, Robert K. "Decision Support Systems: An MIS Manager's Perspective." **MIS Quarterly**, Dec. 1981, 5(4), 35-48.

information. Only then will all information components be successfully integrated in a manner which meet the organizational goals.

The philosophy of information resource management is beyond the scope of this study. It is only mentioned here to identify it as the latest trend in the evolution of management approaches to information.

The Output

The output is information. The form and format of the output can vary greatly. In a traditional DP environment, the most common example of output is the printed report which is generated by the system at predefined times in a predetermined format. The format is difficult and time-consuming to change, and often the DP department must be *convinced* that the change is needed before they will respond.

In both MIS and DSS environments, the emphasis is on the flexibility of the report. Ideally, the user should be able to choose the content and composition, view the result on the screen, change it if desired, then have it printed in hardcopy or stored electronically for use at a later time. Each DSS and MIS system allows various combinations or portions of these ideal possibilities.

B. Educational Applications

Information systems have become as sought after in educational institutions as they are in any business. To ensure effective decisions, educators, too, require current reliable information. "The complexities of our educational institutions have altered the way administrators spend their time. ...Today educational administrators are faced with a vast array of problems: declining enrollments, rising costs, and demands for more services" (Kerstetter, 1983:673-4). Because of these changes, it is not surprising that there is a growing interest and demand in educational administration settings for computerized systems which record and process student records, student marks, teacher qualifications, student enrollments, courses

offered, and teaching assignments.

As one example, Kerstetter (1983) outlines the various computer support systems used to assist administrative decision-making at Gallaudet College. He provides an overview of the financial, facilities, and personnel systems along with their uses, users, and advantages. He does not recommend any particular hardware or software product. Instead, he stresses that the goal for any effective system must be to provide current, reliable information to those who require it. In conclusion, he states:

> [c]omputers offer the administrator valuable assistance in the decision-making proeess. Whether a microcomputer or a mainframe computer is used for this process, the overall effect should be improved decisions by administrators as they have access to the necessary data for decisions (1983:680).

The need for such information systems is not restricted to either large institutions or large American centres. The Edmonton Public School Board echoes exactly the same concerns in a final report submitted to Alberta Education. "School administrators are becoming increasingly interested in the local application of computer technology to school information management" (1985:1). The report evaluated two minicomputer based school information management systems to determine if they were suitable, affordable, and justifiable at the school level.

Alberta Education, itself, has demonstrated a desire to provide leadership in the area of information management. The department established a unit called Corporate Information Systems (CIS) to be responsible for research and development in this area.

C. The Development Cycle

Users want an information system to provide them with the right information at the right time in the right form. Yet, information systems developed using traditional development cycles have fallen short of this goal. The traditional development cycle consists of the eight stages defined below.

1. Requirements:

   the needs are identified.

2. Specifications:

   the outputs to be produced, inputs to be used, resources available, and the procedures to be followed are outlined.

3. Design:

   the components and modules needed to meet the specifications are written.

4. Programming:

   the code needed to meet the design specifications is written using procedural languages such as COBOL or PL/1.

5. Testing:

   the programs are run, tested and debugged.

6. Integration testing:

   when operational, the program must run on an existing integrated system which runs several other programs simultaineously. The program is tested in this actual integrated environment to determine if there are problems.

7. Deployment:

   when the testing is complete, the program or system goes into production. That is, it is used under real circumstances; the testing is complete.

8. Maintenance:

   programming staff are required to make alterations, input data, and delete old data. (Martin, 1984:178).

This is a rigid sequencial approach characterized by unpredictable results, cost overruns, and painfully slow development. Each stage uses the results of the previous stage; therefore, undetected errors or misinterpretations carried forward magnify errors at subsequent stages. This approach "can work well *if and only if* the end users' requirements can be specified in fine detail before design and coding begins" (Martin, 1982:52). This is rarely possible. It is not only the nature of the development cycle, but also the programming languages used (COBOL, PL/1, FORTRAN) which demand these precise specifications. Most users are unable to

conceptualize what they want initially; thus, the development process is doomed from the beginning. A more flexible process which is responsive to the user and uses productive, easy to use, flexible tools is required if the development of information systems is to become successful. Fourth generation languages have been heralded as the panacea to these problems.

D. Fourth Generation Languages

The first generation of computer languages was machine language. The second generation was assembler level languages. The third generation was machine-independent languages called "higher-level" languages such as COBOL, PL/1, FORTRAN and BASIC (Martin, 1982:28).

Third generation languages forced the user to understand the computer. They were procedural languages; the computer made no assumptions; and therefore, the programmer had to define every minute detail. This required precise specifications, several lines of code, and extensive testing and debugging. Fourth generation languages, on the other hand, use nonprocedural code; and additionally, many have procedural code as well. A nonprocedural language allows the user to concentrate on *what* is to be done rather than *how* it is to be done. A good example of a nonprocedural language is VISICALC. This software application allows the user to design spreadsheets using the same conceptual process that he or she would use if designing it on paper. The user does not need to know how the machine performs the calculations, how the files are stored, or how the printout is formatted. With third generation languages, each of these aspects would have to be carefully planned. It is not difficult to understand the tremendous popularity of such software.

Figure 2.3 provides an example of a program written in four different languages. All four programs produce the same result (Martin, 1982:182-183). Note that the NOMAD example is much easier to read and interpret. It is more English-like. The words "READ", "LIST", and "AVG" (average) are interpreted by the machine, and invoke a detailed series of instructions which are invisible to the user.

NOTICE

The material contained on this page was removed because the copyright permission was unavailable. This page contained a computer program written in four different languages: COBOL, FORTRAN, BASIC, and NOMAD. The COBOL program was 58 lines. The FORTRAN program was 10 lines. The BASIC program was 11 lines. The NOMAD program was 1 line.

ORIGINAL SOURCE

Martin, James. **Application Development Without Programmers**. Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1982, 182-183.

What is the definition of a fourth generation language?

For a language to be worth calling 'fourth generation' it should have the following characteristics:

1. It is user-friendly.
2. A nonprofessional programmer can obtain results with it.
3. It employs a data base management system directly.
4. Procedural code requires an order-of-magnitude fewer instructions than COBOL.
5. Nonprocedural code is used where possible.
6. It makes intelligent default assumptions about what the user wants, where possible.
7. It is designed for online operations.
8. It enforces or encourages structured code.
9. It is easy to understand and maintain another person's code.
10. Non-DP users can learn a subset of the language in a two-day training course.
11. It is designed for easy debugging.
12. Results can be obtained in an order-of-magnitude less time than with COBOL or PL/1 (Martin, 1984:32).

In addition to these characteristics, these languages can be categorized according to their capabilities. A fourth generation language would have one or more of the following capabilities:

1. Data base query languages:

   these languages allow the user to write simple requests to search, sort, and extract data from a data base.

2. Decision support tools:

   these languages support decision-making. They allow the user to access, build or extract data bases which can then be used for calculations. Some examples allow the user to build financial or statistical models to make projections about the future.

3. Graphic languages:

   these languages make it very simple for the user to generate various types of graphs using existing data.

4. Application generators:

   most of these languages operate with data bases. They contain modules which can generate an entire application (or program).

5. Report generators:

   these languages allow the user to extract data from a data base and generate a formatted

report with a few simple commands. The language makes many intelligent assumptions about the report format. These defaults can be overridden if desired. Good report generators allow substantial arithmetic and logic operations.

6. Very high-level programming languages:

   these languages such as FOCUS, NOMAD, NATURAL, and RAMIS allow the programmer to achieve results significantly faster than third generation languages. Most employ a data base management system; and many employ report generators, graphic generators, and other generators. (Martin, 1984).

Not all fourth generation languages have all of these capabilities. They are not general purpose languages. Instead, they have specialized capabilities and should be chosen to fit the specific application. Fourth generation languages are more productive than previous languages or software tools. Writing the program code is faster, more accurate, and easier to debug and alter. "These so-called fourth generation languages are so much better than prior languages (such as Fortran, COBOL, Basic, PL/1, etc.) that ... [information system] developers should only consider using the prior generation of software tools in very unusual circumstances" (Meador and Mezger, 1984:268). They are so much better that "an analyst can create a working application faster than he could write a detailed specification" (Martin, 1984:40).

This is not meant to imply that these languages are simplistic. Instead, a "property of a [fourth generation] language is that *to start to use it should be easy*, but that the user can continue to learn more about it and improve his/her skills for a long time" (Martin, 1982:17). In fact, Martin and others would divide fourth generation languages into two groups: those suitable for end users, and those suitable for DP professionals. This is not a detriment, but emphasises the need to assess the uses and users to ensure the most appropriate software is selected.

Prototyping

These new highly productive languages also facilitate a more flexible development approach. Rigid specifications are not necessary; prototyping is possible. Prototyping incorporates a learning process into the system design; it assumes that precise requirements are not always definable before system construction. Prototyping allows the development and experimentation necessary to determine information needs. This is crucial because "users do not know what they want until they use a version of [the information system]" (Martin, 1984:44). Thus, using the prototyping approach, the final version of the information system will evolve. This is essential for "the best information system is designed when the user conceives the solution because, in the end, it must be his or her system" (Thierauf, 1982:7).

Selecting a Fourth Generation Language

Choosing and installing a fourth generation language is a major initiative for any organization. A comprehensive set of selection criteria are required. Meador and Mezger outline an example of such criteria. Although they refer specifically to decision support systems, their approach has implications for the management of information in general. For example, they stress the "necessity of matching the range of language capabilities to the range of organizational needs" (1984:268) which is an essential criteria for any information system. The factors include:

1. end user needs assessment and problem diagnosis,
2. critical success factors,
3. feature analysis and capability review,
4. demonstration prototype development,
5. external user surveys,
6. benchmark and simulation tests, and
7. programmer productivity and end user orientation analysis.

E. The Change Process

The primary purpose of an information system is to support the users. Because of this, it is essential to consider and plan for the effect of the introduction of new technologies on the people involved. Change is difficult to accept. Developing and implementing a new information system is exactly that, a change. As such, it is essential for the initiator to be aware of the change process, know the factors that influence change, and more importantly know how to influence those factors.

Many researchers identify three phases in the change process: Berman and McLaughlin (1976) refer to initiation, implementation, and incorporation; Rogers (1962) refers to awareness, trial, and adoption; Lewin (1947) refers to unfreezing, moving, and freezing; and Fullan (1982) refers to adoption, implementation, and continuation. Although the names are different, the meanings of each stage have a high degree of consistency from one to the other. Essentially, phase one consists of "the process which leads up to and includes a decision to adopt or proceed with a change; ... phase two involves the first experiences of attempting to put an idea or program into practice; ... phase three refers to whether the change gets built in as an ongoing part of the system or disappears by way of a decision to discard or through attrition" (Fullan, 1982:39). Fullan's labels will be used for the following discussion: adoption, implementation, and continuation.

Adoption

Adoption is the process by which people make a conscious decision to embark on an initiative to bring about a change. The factors affecting the adoption process are discussed below.

1. Existence of quality innovations: there must be viable innovations in existence.
2. Access to information: people must be aware that such innovations are available. For example, if they do not know that information systems exist, they are not going to seek a solution.

3. External pressure: the successes of competing organizations create pressures for other organizations to act.
4. Resources: financial and other resources (e.g. training) must be available.
5. Advocacy: a person or group of people within an organization can promote a change. (The advocate's position within the organization will determine the magnitude of his/her influence.)

Implementation

"Implementation consists of the process of putting into practice an idea, program, or set of activities new to the people attempting or expected to change" (Fullan, 1982:54). Fullan identifies three groups of factors which affect implementation.

1. The first group, **change characteristics**, deal with the characteristics of the change or innovation, and the impact that these characteristics have on the people involved with the change.
   a. Need for change: people involved must have an awareness or perception that present procedures could and should be changed.
   b. Clarity: the extent that the goals, objectives that are to be accomplished through the change are consistent with the organizational goals.
   c. Complexity: the difficulty and extent of the change required for those involved.
   d. Product quality: an awareness or assurance that the proposed innovation is of the highest quality, will improve procedures, and will be easy to learn and implement.
2. The second group, **organizational characteristics**, deal with the past experiences of the personnel within the organization; and the type and evidence of support that will be provided to the people within the organization.
   a. History of innovation attempts: passed successes or failures will influence the predisposition of participants.
   b. The adoption process: if the adoption process has yielded a specific, high-quality,

needed innovation, consistent with organizational goals, then implementation will be positively influenced.

c. Support and involvement of administration: the administration must be preceived as supporting and assisting the change.

d. In-service support and training: people need training, and need to know that it will be provided.

e. Time-line and evaluation: implementation is a process; it requires time. The time-line must be planned, managed, and realistic.

3. The third group deal with **departmental characteristics**.

Essentially, a positive working climate will positively affect implementation. Change agents must recognize that superiors, staff relations, as well as the characteristics and orientations of individuals interrelate to form that work environment.

Continuation

Successful implementation does not guarantee that a change will become part of accepted procedures. Continuation of a change depends on these factors:

1. the thoroughness of the implementation process,
2. the attitude of users toward the innovation, and
3. the impact of the innovation on users and the organization.

Without evidence of tangible positive benefits, users are unlikely to continue to use any innovation.

F. Implications

Fourth generation languages have been available since the late 1970's. James Martin's book, **Application Development Without Programmers**, was published in 1982. In it, he argued for dramatic changes in the DP environment. He emphasized the need for end-user computing; and gave example after example of companies which had experienced great productivity gains

by implementing fourth generation languages. Yet despite these examples, fourth generation languages have not been implemented to the extent one might have expected. The question, of course, is why not?

Markus and Robey suggest that "MIS [must] broaden its perception of well-designed systems to include human and organizational criteria as well as technical criteria" (1983:204). Productive, flexible computer languages coupled with prototyping methodologies are not sufficient to guarantee the successful implementation of an information system. The dynamics of the change process, in general, and the human dimension, in particular, must also be incorporated.

This human dimension must include not only the users, but also the computer personnel, themselves. It is false to assume that the DP personnel will unquestionably and automatically accept and implement innovations in their field. "Despite their role as agents of change for the rest of the organization, technical people often turn out to be very conservative in their approach to their own work" (Abbey, 1984:110). It should not be surprising that DP staff exhibit a resistance to change the same as others. To adopt and use these new techniques represents a change for DP personnel. Typical of anyone involved with an innovation, they want to know why the change is imminent, and what it will mean to them (Fullan, 1982). A study conducted by Keen, Meador, and Guyote also confirmed that a successful implementation plan must include the human dimension. The authors surveyed users of DSS in various organizations and they asked the users to identify and rate the importance of the characteristics of DSS implementation and use. Although the respondents had extensive experience with computers, it is interesting to note the following comment:

> When asked to rate the importance of various skills of the data processing department, as well as how they felt their in-house DP group performed in these areas, the survey respondents rated as most important: sensitivity to users' needs, project management skills, and the motivation and education of end users. These, and other 'people' skills, were given priority over technical skills by the respondents (Meador, Guyote, and Keen, 1984:120).

These ratings are consistent with the factors identified in the change process. People are the key. "[P]eople are much more unpredictable and difficult to deal with than things.

Unfortunately, they are also much more essential for success" (Fullan, 1982:54).

As a whole, the literature suggests some specific approaches and tools for the design, development, and implementation of information systems. Specifically, these include:

1. prototyping methodologies which are more flexible than previous methodologies,
2. fourth generation languages which are more productive than earlier languages, and
3. implementation strategies which focus on the involvement and needs of the users in an effort to incorporate the human dimension into the process.

These recommendations found in the literature are incorporated into the design of this study. The specific steps of the research design and the rationale for each are outlined in the next chapter.

Chapter III

Methodology

This study is a case study. The researcher designed a process to select and implement an information system. This process was carried out within the context of the Edmonton Regional Office of Education. The researcher is an observer/participant in this study. As observer, she was able to observe and evaluate the process used; and as participant, she was the project leader. This chapter describes the study design (the process), the rationale for the steps involved in the process, the data collection methods, and the data analysis procedures.

A. Research Design

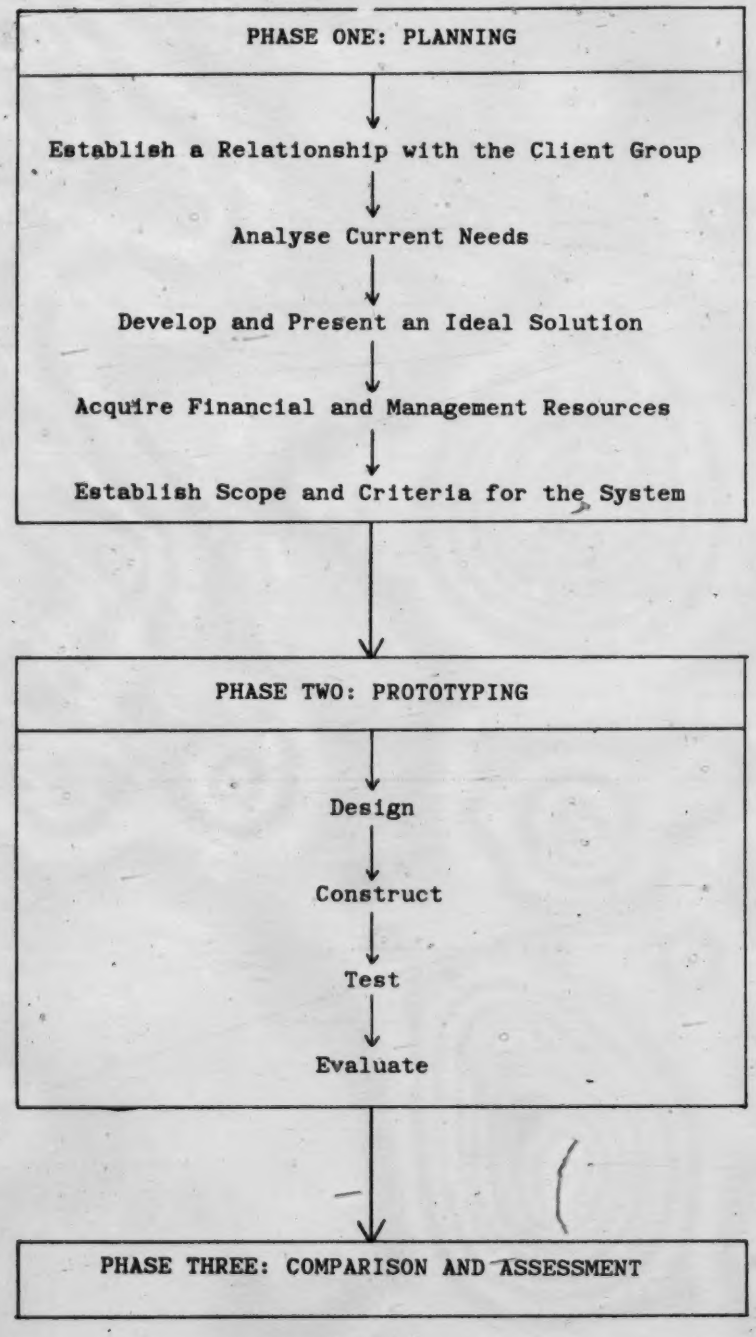
The study design consisted of three phases and related subcomponents:

1. Phase One: Planning.
    a. Establish a relationship with the client group.
    b. Analyse current needs.
    c. Develop and present an ideal solution.
    d. Acquire financial and management resources.
    e. Establish scope and criteria for the system.
2. Phase Two: Prototyping.
    a. Design.
    b. Construct.
    c. Test.
    d. Evaluate.
3. Phase Three: Comparison and Assessment

Each phase and the respective subcomponents are described in detail below and illustrated in Figure 3.1.

Figure 3.1

Methodology



Phase One: Planning

Establish a Relationship with the Client Group

As discussed in Chapter One, the Management and Finance Plan gave the Regional Office personnel new responsibilities. In August 1984, the researcher arranged to meet with a senior administrator in the EROE to discuss the ways in which the introduction of MFP was impacting the role of the regional offices. What changes were imminent? What were the results of these changes? The most immediate concern identified by the senior administrator was the MFP grants. It was now the responsibility of the regional office staff to monitor and track these grants. The senior administrator recognized that new and improved information sources were essential to enable staff to adequately monitor and track the grant approval process. Technological solutions had been considered; however, the EROE staff did not have the time nor the resources required to investigate the feasibility of such solutions. As a result, the senior administrator was very receptive to the researcher's offer to conduct a study which would do exactly that.

Following discussions with the senior administrator, the researcher drafted a study proposal outlining the design and intent of the study. For the EROE, the study would determine the information needs, and select and implement an information system to meet those needs. For the researcher, the study would provide a setting in which to observe the interaction of need, technology, and change.

The researcher submitted the proposal to the senior administrator in September, 1984. As a result of the proposal and subsequent discussions with the senior administrator, the roles and responsibilities of the researcher and the EROE staff were formalized. Communication channels were established and cooperation assured. Specifically, the following procedures were delineated, clarified, and accepted.

1. The study would begin in late November, 1984 and be completed by April, 1985.
2. The researcher would be the project leader and direct the process.
3. The information system developed would be a pilot system, and would provide the

information needed to monitor and track the MFP grants.

4. The researcher would build two versions of the information system: one using a microcomputer DBMS and one using a mainframe computer DBMS. The capabilities of a microcomputer based and a mainframe computer based data base management system would be compared.
5. The researcher was given permission to visit EROE and interview staff as required.
6. An EROE staff member was designated as a liaison officer for the project. This person would assist the researcher in interfacing with staff as required.

Analyse Current Needs

As a starting point, it was necessary to determine what information was required for monitoring and tracking the grants, and to identify the current methods used for obtaining this information. This was achieved by the following steps.

1. Examine MFP policy documents and procedure manuals developed by Alberta Education and the EROE.
2. Compile a list of the grants and identify the forms associated with each.
3. Interview the two support staff who were responsible for maintaining the grant ledgers.
4. Develop a document flowchart for each of the nineteen MFP grants and the Form A and Form B.

The document flowcharts identified the EROE staff members who were involved in the grant approval process for each grant. All of these people were interviewed to determine what their informational needs were with respect to the processing of the grants. In addition to the formal data collection methods: document flow charts and interviews, the researcher also collected data by informal methods such as observations, casual conversations, and field notes.

Develop and Present an Ideal Solution

Upon the completion of the analysis of current needs, a comprehensive picture of the information needs and the information flows emerged, the researcher was able to determine the data elements required, where each data element could be obtained, and the relationship between the data elements. Taken together all of these data elements defined the ideal information system.

A staff meeting was arranged for the researcher to present the ideal solution. At the meeting, the staff were given an opportunity to comment on the suitability of the system and to suggest modifications and/or enhancements. This meeting served other purposes as well:

1. to thank the staff for their cooperation,
2. to clarify the terms information system, data element, record, and file by presenting meaningful examples,
3. to present a summary of the interview results,
4. to obtain feedback on the proposed system,
5. to outline the scope of the ideal system, and indicate how and why the scope of the test solution would be limited, and
6. to explain the steps in the Prototyping Phase, and indicate that some ERO[illegible] staff would be asked to participate in the testing procedures.

Acquire Financial and Management Resources

Although there were no direct payments made to anyone involved in this study, several people within two Alberta Government Departments (Alberta Education and Public Works, Supply and Services) contributed their time, expertise and/or resources to make the study possible. The specific contributors and contributions are listed below.

1. The EROE staff granted the researcher complete access to their work environment. The staff not only provided access to files, journals, and any pertinent information, but also willingly took the time to be interviewed by the researcher, fill in

questionnaires, and attend presentations.

2. The data base administrator for Alberta Education arranged a computer identification for the researcher so that she could access the Alberta Government central mainframe computer and the mainframe DBMS software, FOCUS.
3. Planning Services Branch, Alberta Education provided liaison with other government departments, offered clerical assistance for data entry, and absorbed the computer processing costs incurred by the researcher.
4. Two system analysts at Information Services, PWSS took the time to share their expertise regarding the use of FOCUS and PC/FOCUS.
5. Finance and Administrative Services Branch, Alberta Education allowed the researcher to use their copy of the microcomputer DBMS, PC/FOCUS.
6. Finance and Administrative Services Branch also allowed the researcher the use of their terminal room and the necessary hardware as required. Note: Two hardware configurations were made available to the researcher in the terminal room of Finance and Administrative Services, Alberta Education:
   a. an IBM PC/XT using the PC DOS operating system, an IRMA board[4], an Epson MX-100 dot matrix printer, and an amber monitor, and
   b. an IBM 3278 terminal connected to an IBM 370 mainframe computer using the CMS operating system at the Alberta Government Computing Services in Edmonton.

Establish Scope and Criteria for the System

In the Planning Phase, the data elements and data relationships were identified. The researcher selected a subset of these data elements to use for the test system in the

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[4] IRMA, the Decision Support Interface, is a printed circuit board which plugs into an IBM personal computer. One component of IRMA is the terminal emulator program. This program makes it possible for an IBM PC to emulate a 3278-2 terminal. This allows a PC to serve two functions, as a stand-alone microcomputer and as part of a 327x network accessing the full computing power of the host computer.

Prototyping Phase. Although not the ideal system, the test system was comprehensive enough to enable the researcher to compare the capabilities of the software products, and to observe the response and reactions of the users to an information system.

In addition to identifying the essential data elements in the Planning Phase, the researcher encouraged those interviewed to identify what characteristics they would expect a computerized information system to have. The users expressed desirable software features. In particular, they expected a system which would allow:

1. users to query the system interactively,
2. support staff to maintain and operate the system,
3. reports to be generated easily, and
4. non-computer experts to achieve results by a menu-driven system.

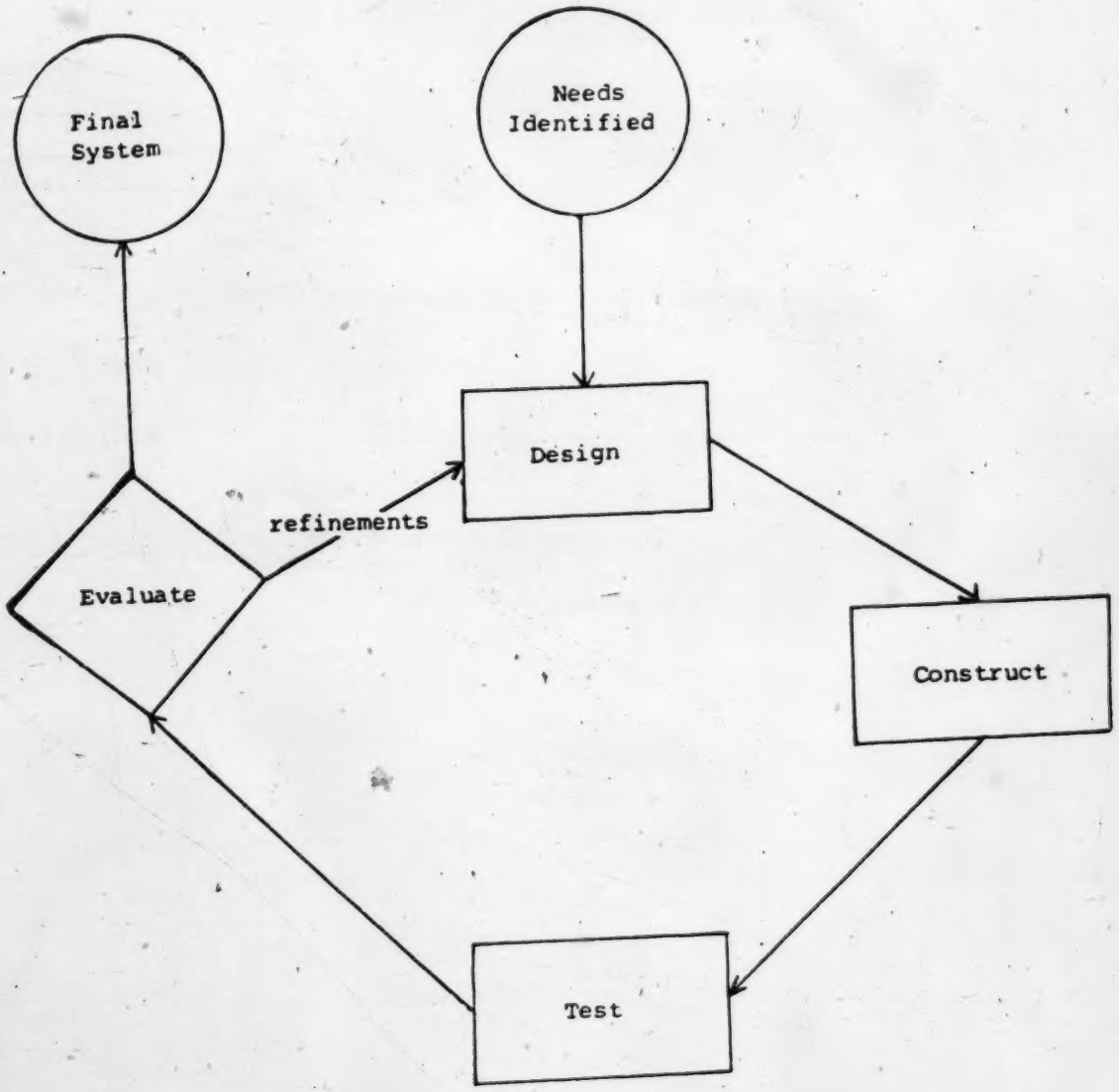
FOCUS and PC/FOCUS met these criteria, and were selected as the software products for the study. Both of these products were available to the researcher, and both were highly recommended fourth generation languages with strong data base management capabilities (Howitt, 1984; Kallenbach, 1984; Martin, 1984; McMullen and McMullen, 1984). By using these products, the researcher was able to apply the prototyping methodology to the development of this system, and to evaluate the use of these highly acclaimed (Martin, 1982, 1984) fourth generation languages in an actual setting. In addition, because these products were a mainframe-microcomputer combination, they facilitated the comparison of the microcomputer and mainframe computer environments. (The specific capabilities and features of FOCUS and PC/FOCUS are explained in Appendix B.)

Phase Two: Prototyping

As explained in Chapter Two, the prototyping process is cyclical; this is illustrated in Figure 3.2. It is a dynamic, interactive process and despite the fact that each of the steps in the process is explained individually there is no intention to imply that prototyping is a linear

Figure 3.2

Prototyping



sequence of steps. At each step revisions are not only expected, but also solicited in an attempt to attain the desired result: an information system which performs according to the specifications of the users.

Design

To design the system, the researcher itemized the detailed specifications, and structures of the system. These specifications were based on the results and suggestions of Phase One. Basic specifications include:

1. what data elements must be stored?
2. should some of the data elements be coded?
3. how are the elements related?

Construct

The construction phase was the technical task of writing computer code. The researcher completed this task. In essence, the code defined data storage, structures, and relationships. Two information systems were constructed: one using PC/FOCUS on the microcomputer, and one using FOCUS on the mainframe computer. Although two distinct systems were constructed, they were identical in function. Each system used the same data elements and these elements were related to each other in the same way: the file definitions were identical. Once the two systems were complete, a sampling of data was entered into the mainframe system. Then using the communications programs resident on the IRMA board, the researcher transferred the data from the mainframe environment to the microcomputer environment.

Test

To determine if the system performed in accordance with the design specifications, the researcher organized informal testing procedures. This enabled the researcher to check the logic of the design with users as the system was developed. Suggested changes and/or improvements were incorporated into the system. Additionally, these initial users provided

suggestions for the development of documentation, and evaluated the clarity of the wording of the report descriptions used in the menus.

Evaluate

The evaluation had three purposes: firstly, to determine how well the information system satisfied the users' needs; secondly, to compare the capabilities and performance of the microcomputer based and the mainframe based DBMS software; and thirdly, to observe the reactions and attitudes of the users to an innovation. Arrangements were made for a sampling of the EROE personnel to use each of the information systems. When the hands-on demonstration was complete, each person filled out a questionnaire.

Phase Three: Comparison and Assessment

Although the microcomputer based and the mainframe computer based DBMS software packages were compared and assessed throughout the Prototyping Phase, these points of comparison refer only to the test solution. When the prototypes were completed, the researcher extrapolated the results to project how the two systems would perform if the ideal information system had been implemented. Specifically, the performance of each system was compared with respect to the following criteria:

1. maximum number of records,
2. response time,
3. number of files that can be related.
4. storage capacities,
5. cost, and
6. maintenance.

B. Rationale

This study was designed to assist the regional office staff with the selection and implementation of an information system. But in addition to this obvious outcome, a second objective was to observe the interrelationship of need, technology, and the change process with respect to the implementation of an information system. Therefore, the study was designed to include these factors so that in the final summation the interrelationship and interdependence of each factor could be observed and analysed.

The identification of the need for an information system was the focus of the Planning Phase. The specific steps taken were chosen in an effort to thoroughly identify the need by using a variety of methods. Through the use of document flow charts and formal interviews the needs were identified. Through the group discussion and questionnaire the needs were refined, and clarified. The results of the formal methods were cross-checked with the results of casual conversations, observations, and field notes to add another perspective to the final assessment of the needs.

Technological alternatives were investigated by reviewing the literature, and interviewing system analysts. A choice was made. Then the Proptotyping Phase provided an opportunity to evaluate the technical proficiency of the DBMS software selected, to evaluate the capabilities of the information system within each of the hardware environments, and to observe how naive users responded to the technological solution selected.

With respect to change theory, the factors that Fullan (1982) identified as influencing adoption and implementation were identified, and incorporated into the study design. The researcher attempted to involve and inform as many people as possible throughout the study. Specifically through the interviews, the researcher had an opportunity to convey to the people why she was in the office, what an information system could do, and perhaps more importantly, determine the extent to which people felt there was a need for change. Identifying what the current needs were, presenting them to the group, and accepting feedback for revision were all activities designed to provide a sense of involvement for the participants. Throughout

the Planning Phase, the researcher constantly tried to make people aware of why the change was happening, whom it would affect, and how. The steps taken in the design of the study process were carefully pre-planned in an attempt to involve and inform all of the people included in the process of change.

By definition, the prototyping methodology addresses many of the factors that Fullan identified. Specifically, it contains a feedback loop which enables users to refine and/or alter a system during the development stage. The development of a system is evolutionary, and user participation is obligatory rather than haphazard. Users are involved and have an opportunity to learn what the change is, begin to understand how it will effect them, and provide input into the final design.

Although Fullan's research has been emphasised as providing the rationale for many of the steps in the study design, other researchers in the field of information systems (Keen and Meador, 1984; Martin, 1984; Montgomerie, 1981) would concur with this rationale. Specifically, each of these authors contend that a successful implementation strategy must emphasise three components: thorough strategic planning (the identification of needs), a cyclical rather than a traditional development cycle (prototyping), and a responsiveness to the human dimension (change theory).

C. Data Collection Methods

A number of different data collection methods were used to collect data from multiple participants in multiple situations from multiple organizations. Specifically, the methods included formal interviews, informal conversations, observations, field notes, and questionnaires. The participants included support staff, senior administrators, consultants, and system analysts. The situations included individual and group meetings, and telephone conversations. The organizations included five branches within the Alberta Government: Edmonton Regional Office of Education, Planning Services, Computer Services, and Finance and Administrative Services all branches within Alberta Education; and Information Services a

branch of Public Works, Supply and Services. The various data collection methods are summarized in chronological order in the Data Collection Matrix: Table 3.1.

D. Data Analysis Procedures

Although there are some frequencies noted in the results, the main method of analysis is qualitative. Triangulation is used to improve the validity of the qualitative analysis. Triangulation is "qualitative cross-validation among multiple data sources, research methods, and theorectical schemes" (McMillan and Schumacher, 1984:319). For example, assessment of the process used in this study is cross-checked by comparing the findings reported in the literature, the statements made by the participants, and the researcher's observations.

Table 3.1
Data Collection Matrix

Measurement Procedure	Type of Instrument	Date	Population/Event	Analysis	Phase
paper flow analysis	document flowchart	Dec. 84	3 support staff 5 admin staff	descriptive	Planning
interviews	interview schedule	Dec. 84	18 Performance Certifiers 1 Expenditure Officer	qualitative	Planning
Presentation and discussion	observation and questionnaire	Jan. 85	regular monthly staff mtg.	frequencies qualitative	Planning
ethnography	field notes	Dec. 84 Jan. 85		qualitative	all
hands-on analysis	observation, interview and questionnaire	Apr. 85	5 support staff 5 consultants 2 associate directors 1 director	qualitative frequencies	Prototyping
interviews	appointments	Mar. 85 Mar. & Apr. 85 May 85	System Analyst PWSS* DBA** Alberta Education System Analyst PWSS*	qualitative	Planning Comparison

**DBA = Data Base Administrator
*PWSS = Public Works, Supply and Services

Chapter IV

Results

The study began in November, 1984 and was completed in April, 1985. From November, 1984 to January, 1985, the researcher spent approximately twenty half days in the Edmonton Regional Office of Education. While there, several tasks carried out were reading files and procedure manuals, getting to know the staff and the organization of the office, interviewing staff members, observing and conversing with staff, and recording conversations and events. The specific results of these activities are summarized in this chapter. They are grouped according to the three phases of the study design: planning, prototyping, and comparison.

A. Planning

The MFP manual, the grant manual and the Program Policy Manual were used to prepare a list of all of the grants, and to identify the funding formulae used for each. The nineteen grants are listed in Table 4.1. The majority of the grant formulae were driven by enrolments. The Form A and Form B documents which indicated enrolments by school contain essential data for the approval process. Therefore, the flow of both the Form A's and B's were tracked as well as the grant forms. All of the grants were certified (validated) by Performance Certifiers within the respective regional offices, some were approved by an Expenditure Officer within the regional office (internally approved), and some were approved by an Expenditure Officer outside the regional office (externally approved).

Document Flowcharts

The document flowcharts tracked the flow of each document inside and outside the EROE. (See Appendix C for the document flowcharts.) To gather the information necessary to draw these charts, the researcher began by meeting with the Office Manager who provided her perception of the process, and introduced the researcher to the two support staff who recorded the movement of the forms. One secretary was responsible for the Form A's and

Table 4.1

MFP Grants

	Grant Name	Certified by EROE Staff	Expenditure Approval within EROE	Expenditure Approval outside EROE
A:	Early Childhood Services:			
	program unit grant	X		X
	program grant	X	X	
B:	Educational Opportunities Fund:			
	compensatory	X		X
	elementary	X		X
C:	Official and Other Languages:			
	French Language Program	X		X
	Languages other than Fr. or Eng.	X	X	
	English as a Second Language	X	X	
D:	Regional Film Centre	X*		X
E:	School Extension Program:			
	Grades 1 - 12	X	X	
	Adult Basic	X		X
	Grades 1 - 12, Private School	X	X	
	Adult Basic, Private School	X*		X
F:	Special Education:			
	Institutional	X		X
	Block Grants	X	X	
	Gifted	X		X
G:	Teacher In-Service:			
	Grades 1 - 12	X		X
	ECS	X		X
H:	Vocational Education:			
	Academic Occupational	X	X	
	Vocational Education	X	X	

* at the time of the interview, no claims had been made for this grant.

Form B's for both public and private schools. The other secretary was responsible for tracking the MFP grants which were approved both internally and externally. Each person maintained a ledger in which she noted when the document entered the office, who it was given to, when it was returned to her, and where it went subsequently. For the grants that were approved internally, there were two addition ledgers. The amount of the funds approved was recorded by grant name in one ledger, and by jurisdiction name in the other ledger. (See Appendix D for examples of these ledger pages.) This dual recording system was intended to enable the administrative staff to determine the total funds approved by type of grant or by jurisdiction at any given time.

The document flow charts identified who had a role in processing each grant. Those identified were interviewed. In all, twenty-one people were formally interviewed.

Interviews

Between mid November 1984 and December 20, 1984, the researcher interviewed seventeen consultants, three associate directors, and the director. All seventeen consultants were Performance Certifiers, one of the Associate Directors was a Performance Certifier, one Associate Director was the main Expenditure Officer, one Associate Director did not have any specific duties with respect to MFP, and the Director was the alternate Expenditure Officer. The following questions were asked.

1. In your particular position, what information do you require to verify the Grant Approval Forms (GAF)?
2. What information do you require to fulfill the monitoring function of the MFP?
3. What other information would you like to have available to assist you with your duties?

The information used to verify the grants varied from simple to complex. Each person had unique requirements as dictated by the GAF. A simple example was the Institutional Grant for Special Education. The Performance Certifier checked a list of approved Special Education institutions which was issued by Alberta Education. If the name of the institution

was on the list, the GAF was certified; if the name was not on the list, the GAF was not certified. A complex example was the Vocational Educational grant. The formula for this grant was based on course equivalent units (C.E.U.). A C.E.U. is the number of students in a particular course multiplied by the number of credits for that course. The Performance Certifier took the enrolment data from the Form A, checked the number of credits offered for this course, calculated the C.E.U.'s, and checked this result against the result on the GAF. The Performance Certifier then verified that the teacher instructing the course had the necessary qualifications (usually journeymen papers), and that the school had the approved facilities required to offer this course. If all of these criteria were met, the grant was approved; if not, the grant was not approved.

At the time of the interviews, the staff had not finalized the monitoring criteria. Therefore, they were not able to indicate precisely what they would need to help them with this process. However, some people knew or speculated that monitoring would require:

1. lists of schools offering special programs,
2. numbers of pupils served by a particular special program, and
3. a method of indicating where and if a copy of the policies, procedures, and guidelines existed.

Six people indicated that they were satisfied with the information presently available and the methods being used. However, the other fifteen people expressed an interest in having additional information available, and indicated that they felt a change in current procedures was required. Their suggestions are listed in Table 4.2.

Although there were two Expenditure Officers designated within the Office, only one person conducted internal approvals. At the time of the interview, this person had no concerns regarding the approval process, but anticipated that there would be a variety of information requests required in the near future. These concerns were divided into two categories. For the grants approved externally, there was a need to know where they were located, and what date they had left the office. For the grants that were approved internally, he felt that the following

Table 4.2

Information Requested

No. of requests	Request
7	teacher qualifications, teaching assignments
4	program location, no. of students enrolled
3	revise and/or coordinate forms to avoid duplication
2	indicate if policies are in place (yes, no)
1	demographic data re enrolments, teachers

information would be needed:

1. total funds approved for each grant,
2. total funds approved for each jurisdiction,
3. total funds approved, and
4. lists of jurisdictions that had not made a claim for a particular grant.

The Ideal Information System

Based on the results of the interviews, paper flow analysis, grant forms, and conversations, a list of data elements was developed and organized into meaningful groups or structures. These data elements are listed in Table 4.3. This is referred to as the **ideal information system**. It contains all of the data elements identified. If the necessary time and resources had been available, this ideal information system would have been constructed.

The data elements for the ideal information system were clustered into six groups. Within each group, the data elements referred to one entity. The six entities included: jurisdiction, public schools, teachers, courses, grants, and private schools. An information system would need to be designed to link the data elements from one entity to another as required. For example, a report listing all of the High School French teachers would also include the name of the high school and the jurisdiction because the data from the school,

Table 4.3

Elements Required for Ideal Information System

1. JURISDICTION
   - code
   - name
   - address
   - phone number
   - RITE
   - type
   - superintendent
   - chairman
   - staff segment
     - name
     - position
2. PUBLIC SCHOOL
   - school code
   - jurisdiction code
   - zone
   - name
   - address
   - phone
   - principal
   - type
3. TEACHERS
   - name
   - qualification
   - certificate
   - teaching assignment (course number)
4. COURSES
   - number
   - name
   - enrolment
   - teacher
5. GRANTS
   - code
   - name
   - rate
   - eligible
   - date processed
   - amount approved
   - paid to date
   - balance owing

6. PRIVATE
   - code
   - zone
   - name
   - address
   - phone
   - principal
   - type
   - affiliation
   - grades approved
   - grades offered
   - teacher structure
     - name
     - qualifications
     - teaching segment

teacher, and jurisdiction entities would be linked.

Presenting A Solution

On January 7, 1985, the researcher addressed the EROE regular staff meeting to present the results of the Planning Phase to the staff, and to gather feedback on the purposed system. The researcher also clarified that only a sample of the ideal information system would be used for the test system, and that some of the staff would be asked to take part in the testing procedures.

Discussion Results

Overhead transparencies of Figures 4.1, 4.2, and 4.3 were used to present examples, and explain and clarify the terms data element, record, file, information system, and value. (The data elements listed in these three figures are fictitious.) Based on interviews and conversations, the researcher realized that these terms were not clear to everyone. The presentation attempted explain the vocabulary through relevant examples, attempted to raise the comprehension level of the users for further discussions, and attempted to facilitate the use of these terms in both the questionnaire and the prototype testing procedures. Despite these efforts, the the questions being asked indicated that some staff members had a very clear understanding of the terms while others did not.

Figure 4.1

Information System Terminology

name	zone	category	principal	approved grades	offered grades
Alberta College	3	1	Mr. Smith	10 - 12	N/A
Concordia College	3	1	Mr. Jones	10 - 12	10 - 12
Edmonton Academy	3	2	Mrs. White	1 - 12	1 - 12
Ecole Bugnet	3	1	Ms. Noir	7 - 9	N/A

DATA ELEMENTS

name of the data element	value of the data element
name	Edmonton Academy
zone	3
category	2
principal	Mrs. White
approved grades	1 - 12
offered grades	1 - 10

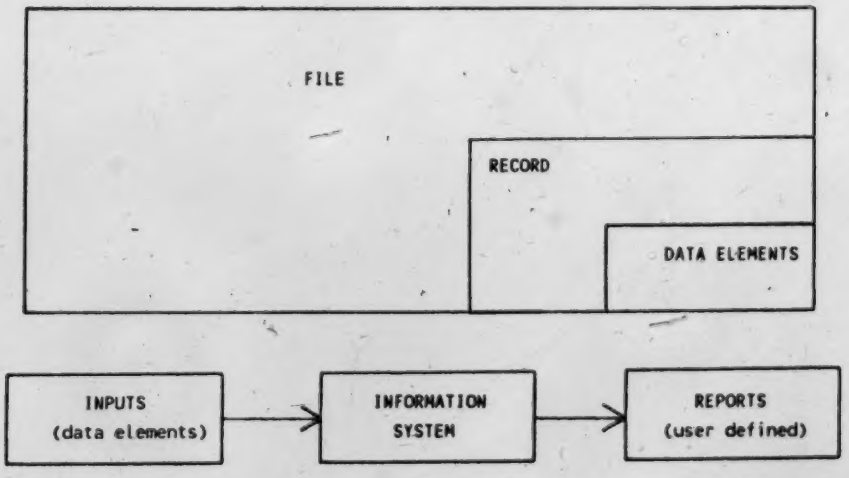


Figure 4.2

Sample Report 1

DATA SHEET
==========

name:	CONCORDIA COLLEGE		
address:	121 Main St.		
principal:	Mr. Jones		
phone:	779-3434		
zone:	3	grades approved:	10 - 12
category:	1	grades offered:	10 - 12
enrolment:	n/a	special programs:	French
# of Teachers:	12		

Figure 4.3

Sample Report 2

PRIVATE SCHOOLS

Category 2

NAME	PHONE	PRINCIPAL
Alberta College	989-0123	Mr. Smith
Concordia College	779-3434	Mr. Jones
Ecole Bugnet	567-4433	Ms. Noir
Edmonton Academy	343-7181	Mrs. White

Questionnaire Results

A questionnaire was distributed to the 22 people present at the January 7, 1985, meeting to obtain their feedback on a proposed information system. (See Appendix E.) The questionnaire listed the elements that would be available, and asked the respondents to check off those that they would wish to have available. Fifteen questionnaires were returned. All said they would use a data sheet on public schools. All but one said they would use a data sheet on private schools. (The one person who responded "no" did not deal with private schools in the course of his work.) The responses are summarized below.

The following data elements were considered unnecessary or of limited use by the respondents:

1. zone,
2. school code, and
3. jurisdiction code.

The following data elements were added by the respondents:

1. names of teacher,
2. teaching assignment,
3. teacher's qualifications,
4. enrolment by grade and by sex,
5. date of last monitoring,
6. monitoring report available (yes, no),
7. what curriculum is used (for private schools),
8. does school offer an ECS program, and
9. enrolment by course and by sex.

Most of the respondents indicated that they would use all of the reports listed on the questionnaire. Seven respondents indicated that they would not use the report which lists schools by enrolment. Other respondents added a report to list schools by type (e.g. junior high, elementary).

General Observations

In addition to the results gleaned from the formal data collection activities, there were results obtained from informal activities as well. Specifically, by making daily visits to the office, the researcher was gradually accepted as a member of the staff, and was able to become an unobtrusive observer. In this role, she observed and noted the actions, perceptions, and reactions of the participants to the impending change.

At the time of the study, the introduction of the MFP was exerting external pressure for change on the EROE staff. Although each member of the EROE staff viewed the changes related to MFP from his or her own unique perspective, some generalizations were noted according to the level of the staff position. The senior administrators had the most global perspective. They viewed MFP as an entity and were concerned with the needs and procedures from the perspective of Alberta Education. They were trying to anticipate how they would be expected to report for the Annual Provincial Education Review, what form the monitoring procedures would take, and how these monitoring requirements would impact the workloads of staff. The consultants viewed MFP from the perspective of the grant they certified. They felt that the various forms used should be coordinated and improved to provide better information and avoid overlaps from one to the other. The support staff were concerned with the ways in which MFP would alter the daily procedures within the Edmonton Regional Office. There was no precedent for the two support staff who were responsible for the tracking ledgers. Therefore, the procedures were evolving as the need dictated. They were also concerned about keeping the ledgers current. They could not control how quickly the Performance Certifiers returned the forms, and they had to maintain these ledgers in addition to their other job duties.

Although the perceived need for change varied from person to person, there was a distinction in the attitudes of the professional and the support staff. In general, the professional staff expected that they would be consulted when a change was imminent, and they expected that they would have some input into any proposed changes. The support staff, on the other hand, did not expect to be consulted. And when they were, they were somewhat

skeptical that their suggestions would have any impact.

The Associate Director and the Director agreed to provide their support for the study; however, this advocacy was not expressed formally to the staff initially. Although the Director circulated a memorandum to request staff cooperation with the researcher, many of the staff were not clear about the reason for the study prior to their interview. It was not until the staff meeting on January 7, 1985, that the support of the senior administrators was formally expressed to the staff collectively. This presentation did not include the support staff, and as a result, the strength of the senior administrative backing was not conveyed to them.

B. Prototyping

The researcher selected a subset of the data elements from the ideal information system for inclusion in the test system. (See Table 4.4.) Three complete segments were chosen: public schools, grants, and jurisdiction information. A file definition was written and a sample of data was entered. Although the file definition for the test system contained fewer data elements than the ideal information system, it was still comprehensive enough to enable the researcher to test the proficiency of the software features, and to enable the users to generate complete and useful reports pertaining to the segments included in the test system. That is, the test system was reduced in size but not in complexity. It still contained the essential features of the ideal system: interrelated segments, coded elements, derived elements, and segments linked many-to-one.

While the researcher performed the mechanics of the design and construction phase of the prototyping process, users were asked to test various components as this work was being done. The comments and suggestions of the users served to verify the logic of the system design, outline the areas requiring clarification in the documentation, and evaluate the clarity of the wording of the menu instructions. The researcher incorporated these suggestions into the test system which was used for the evaluation. Collecting and consolidating the suggestions and feedback of the userswas the essence of the prototyping process.

Table 4.4

Elements Used for Test System

1. jurisdiction information
   - jurisdiction code
   - name
   - street
   - city
   - postal code
   - phone number
   - RITE number
   - central office staff structure
     - name
     - position
2. school information (linked to the jurisdiction)
   - school code
   - name
   - street
   - city
   - postal code
   - phone number
   - principlal's name
   - number of teachers
   - enrollment
   - grades offered
3. management and finance data (linked to the jurisdiction)
   - grant code
   - rate
   - date processed
   - eligible units
   - amount approved
   - amount claimed

The users and the researcher viewed the testing and the evaluation of the system from different perspectives. Therefore, the results of the evaluation of the test system are divided according to the users' assessment and the researcher's assessment. Throughout this discussion, the term FOCUS refers to the use of this software in a **mainframe** environment, and the use of the term PC/FOCUS refers to the use of this software in a **microcomputer** environment.

User Assessment

Once the prototype was running properly, the researcher made arrangements with the staff of the Finance and Administration branch to schedule the hardware for demonstrations.

Both the microcomputer and the terminal which was connected to the mainframe were in the same room. Therefore, two people at a time were scheduled for the demonstration. Thirteen staff members participated: 5 consultants, 3 senior administrators, and 5 support staff. Each staff member spent approximately one hour using the two systems during regular working hours. Each person was exposed to the same demonstration which consisted of these steps.

1. The researcher gave each person a copy of the documentation (see Appendix G), and referred the user to the diagram of the file structure.
2. One person was asked to use the microcomputer while the other person used the terminal.
3. Each person was given a set of sample exercises, and asked to try these on the computer. (See Table 4.5.) During these exercises, the researcher provided assistance as required.
4. After the user had sufficient opportunity to go through the examples, the researcher referred the user to the menu section of the documentation. The user was then asked to use the menu and observe what happened.
5. Having completed these two steps, the users were then asked to exchange machines, and repeat the procedure.
6. When they were finished, they were asked to complete a questionnaire (see Appendix E). If they had any problems understanding the questions, they were encouraged to ask for clarification.

In addition to answering questions, the researcher observed the reactions of the users to both the hardware and the information systems throughout the demonstration.

This test procedure exposed the users to the same information system in two different environments: microcomputer and mainframe computer; and to two methods of report generation: FOCUS commands and menu selection. Each of the four sample exercises used FOCUS commands to generate a report. The FOCUS commands were written in upper case, and the data element names were written in lower case. After the user had completed the sample exercises, the user was directed to the menu selection section of the user documentation. The user followed the step-by-step procedures and generated the same reports by selecting a

Table 4.5

Sample Exercises

1.
```
TABLE FILE sinfo
PRINT sname principal
IF grades EQ 7-9
END
```

   This procedure prints the school name and principal's name for all schools offering grades 7 - 9 inclusive.

2.
```
TABLE FILE sinfo
"Junior High Schools"
PRINT sname principal grades
IF grades EQ 7-9
END
```

   This procedure prints the same report as number 1 with the title, "Junior High Schools", at the top of the report.

3.
```
TABLE FILE sinfo
?F
PRINT sname prin ph
IF grades EQ 7-9
IF zone EQ 2
END
```

   This procedure prints the school name, principal's name, and phone number for all schools in zone 2 which offer grades 7 - 9 inclusive.

4.
```
TABLE FILE sinfo
?F
PRINT sname city
BY jn
IF jc EQ 2120
END
```

   This procedure prints all of the school names and the city or town where they are located for the jurisdiction if the jurisdiction code is equal to 2120.

number from the menu that appeared on the screen.

The reactions and responses of the users to the various components of the testing procedure were observed and noted. In addition, the users recorded their own ratings of the two systems and the two methods of report generation in the questionnaires provided. The results are summarized below.

System

The users suggested three improvements to the system.

1. The grant codes used were L2, L3, E1, S1, V1, V2, and ECS. Except for ECS, these codes were meaningless to the users. Therefore, they suggested that they should be changed to reflect the grant name.
2. Although the users had been told that data relating to teachers would not be part of the test system, many reiterated that such data should be included.
3. Reports should be able to list all schools offering a specific grade (e.g., 7, 8, or 9) rather than just listing schools by type with a range of grades (e.g.,7 to 9). The users pointed out that the grades offered in rural schools vary according to enrolments and the proximity of other schools. Therefore, a school offering grades two to eight, or eight to twelve is not uncommon.

Technical

The users expressed the following technical concerns.

1. The keyboard on the mainframe terminal had an unfamiliar layout. The return key was labelled the enter key, and it was in a different location than the microcomputer. In addition, there were many more keys (such as program function keys) on the terminal keyboard than the microcomputer keyboard.
2. The users who typed well did not like the feel of the stickers on the microcomputer keyboard. (Refer to the Field Notes section of the Researcher Assessment for a further explanation of the keyboard stickers.)

3. Some users felt that the amber monitor on the microcomputer was faint and hard to read.
4. All of the users preferred the scrolling of the microcomputer to the paging of the mainframe. (When the screen on the mainframe terminal is full, the user must advance to a new screen manually by holding done the alt key and pressing the clear screen key. This is a design limitation of the hardware not the software.)

Field Notes

All users perferred to use the menu because they felt that it was easier to use. However, after the short demonstration and explanation, many of the users attempted to compose their own ad hoc reports using some simple FOCUS commands that they had used in the sample exercises. Some suggested that using FOCUS commands directly would be more flexible, and as a result, they suggested that the option to use FOCUS commands should be maintained.

Users indicated their strong satisfaction with the reports by such comments as "this would sure save a lot of time," and "this (information system) would solve the problems we are having tracking the totals for each grant for each jurisdiction." "(The Expenditure Officer) has to see these reports."

Some of the consultants wanted to know if the system would be completed; others asked "when will the system be installed in our office?" Although the consultants did not show any overt resistance to the hardware, some were hesitant to type in the sample exercises due to their poor typing skills. Nearly all of the consultants felt that they would not be direct users of the system.

Two of the support staff stated that they did not like computers and found them confusing. They were reassured that if such a system was installed training and documentation would be made available to assist them. However, they remained skeptical. Following the demonstration, the researcher asked if they found the reports useful. The response was "well it (the microcomputer) is kind of slow." When asked if it was slower

than the procedures that they presently used, the response was "we don't have a computer anyway so it's (the information system) not much good to us."

All of the users noted that the mainframe was faster than the microcomputer, but only five of the participants thought that the response of the microcomputer was a limitation.

Researcher Assessment

On Friday, January 25, 1985, the researcher received approval to use FOCUS on the government mainframe computer. Over the next two months, the researcher spent approximately 50 hours learning and using FOCUS and the mainframe operating system (CMS). By March 2, 1985, the pilot information system was operational. (Appendix B provides additional technical background on FOCUS and PC/FOCUS. The capabilities and special features of the language, and the file structure that it supports are described in detail.)

On Thursday April 4, 1985, the researcher gained access to PC/FOCUS and began building the second system. The initial intention was to download all of the files that were resident on the mainframe, but a problem occurred with the LINK feature which was supposed to allow this facility. Data files which were created within FOCUS could not be downloaded to the microcomputer environment. Only files which were created in the respective operating systems, CMS and DOS, could be transferred from one environment to another. Despite these problems, the researcher was able to have the PC version of the information system operational in approximately eighteen hours. The two systems were ready for testing by April 9, 1985.

Throughout the Prototyping Phase, the strengths and weaknesses of FOCUS and PC/FOCUS were recorded. To ensure that these personal observations were balanced and credible, the researcher interviewed two systems analysts at Public Works Supply and Services (PWSS): one had worked with PC/FOCUS for about a year, and the other had worked with FOCUS for about the same time. The comments of the analysts and the researcher are synthesized below.

System

The response time of the microcomputer is significantly slower than the mainframe. In this study, the menu and the sample exercises that the users were given requested exactly the same reports from the microcomputer and the mainframe. The mainframe response was instantaneous. The response time of the microcomputer varied from one report to another, but the greatest differential was approximately 30 seconds. That is, in one instance, the microcomputer required 30 seconds longer than the mainframe to issue the same report.

If the variation in the reponse time from one system to the other is overlooked, the mainframe and the microcomputer versions of the pilot information system were virtually identical. PC/FOCUS supported exactly the same quality and structure of reports, the same dialogue manager facilities, and the same file descriptions. In fact, the test information systems looked and responded the same; so much so that users were sometimes uncertain which was which.

However, it should be noted that the test system was quite simple. Within the confines of the file design used for this study, the microcoputer-based and the mainframe-based information systems were equal in terms of the reports generated, the data base capacity, and the flexibility of the file design. (See the Comparison and Assessment section of this Chapter for an indication of how the ideal system would have responded in both environments.)

Technical

The essential differences between the physical environments required for the operation of FOCUS and PC/FOCUS are described below.

FOCUS runs on a mainframe computer, and for this reason alone, its usage is restricted to a large organization which has the appropriate hardware. In this study, the researcher contacted the Computer Services Branch of Alberta Education to obtain the necessary computer identification and signon procedures. The next step was to learn some

basic commands for both the operating system and the system editor. It was not possible to use FOCUS in the mainframe environment without learning these basics first.

It is difficult to itemize the costs of using FOCUS. There appears to be no consensus regarding the operational costs of FOCUS on the government mainframe. Some users and developers claim that it is expensive, while others contend that it is inexpensive. These are relative terms; and the question is compared to what. The Information Services Newletter of January 31, 1985, indicated that "in comparison to ADRS II [a data base management system], FOCUS was more flexible, efficient, and consumed significantly less computer resources." The specific costs of generating the same reports are compared in Table 4.6. Although FOCUS showed a substantial saving in each example, it should be pointed out that report generation is only one component of the operational costs. More conclusive data will only become available after FOCUS has been used for a longer period of time in a variety of applications. One thing is certain, the operational costs of FOCUS would be greater than the operational costs of PC/FOCUS. However, other factors must be considered when choosing a particular product.

PC/FOCUS requires an IBM, WANG, or Texas Instrument personal computer with a minimum of 512K (preferably 640K) memory, PC DOS 2.0 operating system, a 10 megabyte hard disk, one floppy disk drive, a printer, and a monitor with graphics capabilities. The software costs $1,400.00 (CAN), and is contained on 11 floppy disks. One disk is called the Activator disk and must be placed in the floppy drive each time the system is booted. The other ten disks can be copied, and loaded onto the hard drive. Only one copy of the Activator disk is sent to the purchaser; therefore, it must be guarded carefully, and a replacement is only issued if the damaged original disk is returned to the vendor.

Once the researcher had arranged to have access to the work area where the microcomputer was kept, work could begin. No computer identification, password, or billing code was required. A microcomputer operates in a stand-alone manner: its

Table 4.6

Comparison of Report Generation Costs[5]

ADRS II	FOCUS	Difference
$ 7.22	$ 1.05	$ 6.17
4.51	0.77	3.74
4.51	0.79	3.72
8.68	0.81	7.87
10.27	1.04	9.23
10.19	1.28	8.91
10.27	0.59	9.68
4.61	0.75	3.86
5.59	1.02	3.86
5.49	0.62	4.87

operation does not affect nor is it affected by the operations of any other equipment or users. Therefore, there is no need for coordination or integration of users as in the case of the mainframe environment.

Theoretically, once hardware and software are purchased, there would be no additional operating costs other than the costs of paper and disks. However, considering the complexity of some features of PC/FOCUS, it is likely that the user would either have to develop the necessary expertise through training, or purchase the service from someone with the expertise. In either case, there would likely be addition costs beyond the purchase of hardware and software. This is not meant to imply that training would not be required for the mainframe version of FOCUS. The point is, training is routinely planned for in a mainframe setting, while training is often an after thought in a microcomputer environment.

Field Notes

The terminal keyboard and the microcomputer keyboard are not the same. Some keys are located in different positions, some are labelled differently, and because the terminal keyboard has more keys than the standard microcomputer keyboard, some keys

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[5] from Public Works, Supply and Services, Jan. 31 (1985), p. 2-3.

are simply missing. In particular, the 327x series of mainframe terminals has 24 special keys on the keyboard called program function keys. The standard IBM PC keyboard does not have these keys, and as a result, combinations of other keys must be used as an alternative. Although this sends the required command to the CPU, it is difficult to remember all of the combinations without referring to the keyboard legend or using the special stickers for the keyboard which are included with the documentation. (See Figure 4.4.)

The file transfer capability was disappointing. In the study, this feature did not work as it was described in the manual. File transfer allows the electronic transfer of data from a mainframe to a microcomputer (downloading), and from a microcomputer to a mainframe (uploading). Although Information Builders Incorporated, the distributors of the FOCUS software, was unwilling to state that the file transfer capability simply did not work, they would admit that there were "some problems with it, and they hoped to have them remedied in the next release." The problems that this researcher experienced were consistent with that of the PC/FOCUS analyst. He also found the LINK feature unsuccessful and followed the steps that the researcher used in the prototyping section to circumvent this problem.

As one would expect, the mainframe computer stores and manipulates significantly larger files than the microcomputer. In the PC/FOCUS documentation some specific numerical limitations were listed. (See Table 4.7.) The files used in this study were tiny in relation to these limits. Other than the slower response time of the microcomputer neither system displayed any limitation in processing the records.

Despite the shortcomings discussed thus far, the researcher found that the two major features of FOCUS used in this study were very powerful, and easy to use: the Report Generator, and the Dialogue Manager. These features are available on both the microcomputer and the mainframe versions of FOCUS and function exactly the same from one to the other.

NOTICE

The material contained on this page was removed because the copyright permission was unavailable. This page contained a PC keyboard layout indicating the key combinations to use to emulate the program function keys for the mainframe terminal keyboard.

ORIGINAL SOURCE

Technical Analysis Corporation. **IRMA Terminal Emulator Reference Manual**. Atlanta, Georgia, 1983.

Table 4.7

Numerical Limits of PC/FOCUS[7]

item	PC/FOCUS	FOCUS
Maximum number of data fields in a master file description	250 fields	no limit
maximum sum of the length of all data fields	4096 bytes	12288 bytes

The TABLE FILE command introduces a subset of FOCUS commands which are used for report generation or information retrieval. These are non-procedural, English-like commands. When a report is printed, FOCUS makes intelligent assumptions and provides column headings and page numbers automatically. Extensive calculations and search criteria can be specified. These features enable the user to find particular items within the file, sort them alphabetically, and calculate and print cumulative totals. As the PC/FOCUS analyst stated "the report generation facility is wonderful. It generates very complex and comprehensive reports with only a few statements."

The dialogue manager facility enables a system analyst or a knowledgeable user to store and catalogue FOCUS commands in FOCEXEC (mainframe) or .FEX (micro) files. These files can then be executed repeatedly by issuing the command EX [filename]. This facility makes it possible to design menus and other masks which allow a user to search the data base and issue reports without any knowledge of FOCUS commands. (Refer to Appendix F for the Dialogue Manager procedures used for this system.)

The enhancements available with PC/FOCUS are not just cosmetic. FileTalk and TableTalk help to avoid and eliminate typing errors by prompting the user for responses through menu selections. The responses are also checked against possible choices as they are entered. In this way, corrections can be made immediately. Both of these features would be welcome additions to the mainframe version.

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[7] from Information Builders Inc., **Guide to Operations**, 1984, p. A-01.

General Observations

Both the researcher and the users involved had to actually experiment with and use the product. The researcher experienced the frustration of learning a new programming language. Needless to say, the researcher did not become proficient with FOCUS or PC/FOCUS; but she did develop an understanding of the skills that would be required for a user to design, operate, and maintain an information system using these products. This made it possible for the researcher to determine if the acquisition of these skills would be a realistic expectation for the users within the EROE.

For the users, the prototype gave them a concrete example of data elements and reports using examples from the regional office. In this way, the users conceptualized the meaning of an information system, and developed a better understanding of how inputs are linked to outputs. They experienced the implementation of an innovation; and therefore, were given the opportunity to understand why such a system was being developed, how it could assist them, and how the implementation would affect them personally. Through this study, they became participants in the process of change.

C. Comparison and Assessment

The response and capabilities of PC/FOCUS were satisfactory with respect to the test system. Would this remain true with respect to the final system? Specifically, the questions are:

1. Will PC/FOCUS support a data base which has the number of fields that are required for the ideal solution?
2. How will the response time change as the file increases in size?

To answer these questions, it is necessary to consider the file structure for the final system, and estimate the number of fields.

The complete file structure would consist of several interrelated files. Each file would contain the data required to describe an entity. "An *entity* is anything about which data can be

stored - a product, a salesman, a part" (Martin, 1984:90). In the case of the regional office, the entities are jurisdictions, central office staff, schools, teachers, courses, and grants. The Bachman diagram[1], Figure 4.5, indicates how these entities are related. For example, the arrowhead indicates that there are many teachers for a particular school. The arrow stem indicates that there is one and only one jurisdiction linked to each school. Table 4.8 indicates the actual and estimated number of fields and records for the test system and the final system respectively.

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[1] Each box represents a data entity. Each arrow represents a relationship between two boxes. The arrowhead indicates a many to one relationship; the arrow stem indicates a one to one relationship (Sweet, Apr. 1984).

Figure 4.5

Ideal System

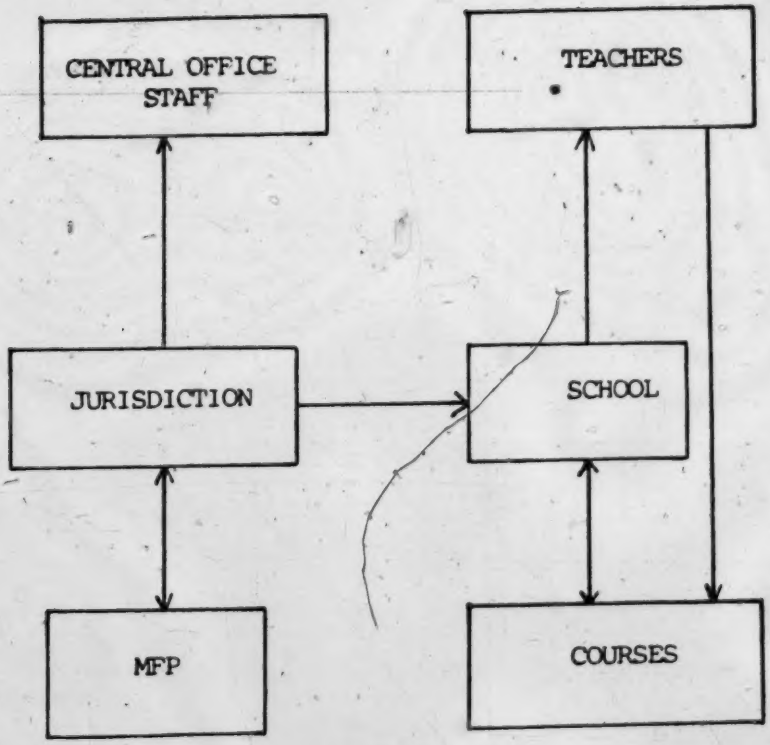

Table 4.8

Test System vs. Ideal System

Test System

file name	fields	number of records
jurisdiction	7	57
school	10	250
mfp (grants)	6	30
central office staff	2	10
TOTAL	25	

Final System

file name	fields	number of records
jurisdiction	7	57
school	10	600
mfp (grants)	6	57 x 6
central office staff	2	57 x 5
teachers	4	600 x 25
courses	4	300 x 40
TOTAL	35	

Based on the information in Table 4.7, 35 fields are well within the numerical limits of PC/FOCUS. However, it is also necessary to consider the total number of records that the data base would contain. For example, the test system had 250 schools and no teachers; the final system would have 600 schools and 15,000 teachers. When a query is issued, the data base is searched. Each record is checked and selected if it has a field which matches the value of the selection criteria. The more records on file, the more records there are to search; therefore, the longer the search will take. Table 4.9 compares the number of records searched if the same query were used on each system.

Table 4.9

Queries: Records Searched (Estimate)

Query	Files Accessed	Test	Final
1. list all junior high schools in zone one	SCHOOL	250	600
2. list the names of all schools within the jurisdiction	SCHOOL	57	57
	JURISDICTION	250	600
3. list all teachers within each school by school name	TEACHERS	n/a	15000
	SCHOOL	250	600

Response time is a result of a combination of three variables: file design, number of fields, and number of records. However, inexamples 2 and 3, response time is solely dependent on the number of records since the file design and the number of fields remain the same.

Table 4.10

Response Times (Estimate)

Query Number	Test System	Final System
1	20 seconds	60 seconds
2	30 seconds	90 seconds
3	n/a	4-5 minutes

Although these are just estimates rather than actual findings, the point is that when the number of records is extremely large (exceeding 10,000 records) in the microcomputer environment, the response time is very slow. As Table 4.10 indicates, it could be conceivable that query three (noted in Table 4.9) could have a response time of four or five minutes. Users within a particular context must decide if these slow response times are acceptable. Undoubtedly, if a mainframe is accessible, the preference would be to use it when the data base exceeds 10,000 records.

Summary

The mainframe and the microcomputer versions of the information system were not equivalent. But the question is to what extent could the microcomputer version meet the EROE

needs? The researcher determined that the answer is dependent on two factors: PC/FOCUS capabilities, and user expertise. As noted above, FOCUS and PC/FOCUS handled the test system equally well. PC/FOCUS supported the same features as the mainframe version. However, there was one limitation. The microcomputer version was not limited in how it handled the data, but it was limited by the amount of data that it handled.

Although there is nothing (other than price) to prevent the EROE from purchasing PC/FOCUS and the necessary hardware, it is unlikely that any information system would become operational without one additional ingredient: expertise. After using the system and observing others use the system, the researcher noted that to use either FOCUS or PC/FOCUS proficiently would require training. This is not meant to imply that these products are restricted to computer professionals; but it does imply that optimal results will not occur without adequate training.

Typical of fourth generation languages, FOCUS does not require the user to learn all aspects of the language to use it. Instead, it is possible to learn selected subsets. For the regional office system, three distinct levels of knowledge would be required: report generation, maintenance, and development. One person or several people could acquire the required knowledge in all areas. But a more likely scenario would be to train four or five people in report generation, one or two in maintenance, and one person in development.

Chapter V

Interpretations, Recommendations, and Conclusions

As noted in Chapter Three, the process used in this study also had an underlying purpose. It was designed to examine the interrelationship of need, technology, and the change process. The examination and interpretation of the interrelationship of these components are discussed below. Then based on this discussion and the other results recommendations and conclusions are presented.

A. The influence of need

When a grant application form is processed by the EROE staff, funds are either approved or refused. The importance of being able to answer inquiries regarding refusals or payment delays cannot be overstated. Therefore, it is not surprising that the senior administrators and the consultants reacted very positively to the test information system despite the fact that it was more limited than the ideal information system. Instantly, they could generate a report indicating the total dollars approved for each grant by jurisdiction or a report indicating the total dollars approved for all of the grants for a particular jurisdiction. Not only would such a system save them time, but more importantly, it would provide them with information which they were presently unable to access easily.

In general, the regional office staff recognized that a change was needed, but how it would be implemented was not their concern. In fact, most of the consultants perceived themselves as indirect users of the system. Only two of them felt that they would actually sit down at the keyboard and generate reports themselves. Instead, the majority liked the system, wanted the information, but would expect one of the support staff to issue the reports.

The need for a better and improved method of managing information was apparent. The need for a change was evident. Yet, prior to the study, there had been no efforts made to address the need. The existence of a need for a change had not motivated the staff to investigate or implement a solution.

B. The influence of technology

Throughout the prototyping and comparison and assessment phases, both the users and the researcher used and evaluated the software, hardware, and the information system. As a result, both the researcher and the users learned that technology could offer a solution. Reliable, flexible data base management programs such as FOCUS were available. However, not one of the users expressed an interest in learning how the system was developed or maintained. Just as they perceived themselves as indirect users of the system, the consultants and support staff also perceived themselves as indirect developers of the system. They did not assume any responsibility for development other than stating what they wanted the system to do. Although they felt that they would not develop or operate the system, they did not give any consideration to who would. To be fair, this may have been because there was no plan to implement the system. However, another possibility was that they were unable to conceptualize what was involved in the development process; and therefore, could not articulate distinct tasks.

Prior to the commencement of the study, both FOCUS and PC/FOCUS and many other reliable data base management software packages were available. At the start of the study, some of the EROE staff made it clear to the researcher that they felt a computerized information management system could provide them with the information that they needed. Yet, no one in the office had investigated the feasibility of such a solution or whether there were suitable products available. In fact, it is unlikely that any investigation would have occurred without this study. Undoubtedly, other factors such as cost and user expertise affected the possibility of an investigation. However, the point is that the mere existence of quality technological solutions did not lead to the implementation of a solution.

C. The influence of change

The need was identified, quality technical solutions were available, but it was only by conducting this study that the EROE began to move toward a solution. Change is a process, not an event. It consists of three phases: adoption, implementation, and continuation. In this instance, the study itself was the change. It was a process composed of several events designed to select and implement an information system.

Guided by change theory, the researcher took specific actions, and specific results were achieved. When the study was completed, the interrelationship of need, technology, and change became clear. Change theory provides a framework for organizing and itemizing the factors which influence the successful implementation of an innovation; and in this instance, need and technology were factors within the process of change. Even though need and technology were significant variables in this study, they were separate factors, and did not constitute a process. A more thorough discussion of the study as a change process follows.

D. The Change Process

Under the direction of the researcher, the participants moved through the adoption phase and into the implementation phase of the change process. Due to limited time and resources, it was not possible to observe the third phase: continuation. Nonetheless, the researcher identified the factors associated with the first two phases of the change process; and analysed what impact they had on outcomes.

Adoption Factors

In Chapter Two, five factors which affect the adoption process were identified: existence of quality innovations, access to information, external pressure, resources, and advocacy. The influence of four of these factors was noted in this study. Each is discussed below.

Clearly, a key factor noted in the adoption phase was **advocacy**. Both the Associate Director and the researcher were advocates of this study. The Associate Director supported the intent of the study and arranged for the researcher to have complete access to the staff and the files of the EROE. The researcher obtained access to the software and hardware required for the study, and developed the system. Without the support and initiative of both the researcher and the Associate Director, the study would not have been conducted.

Everyone involved in this study was not equally aware of the **existence of quality innovations**. The researcher developed the most complete and thorough understanding of the quality of FOCUS because of her background knowledge and because of the nature of the tasks she had to perform in the prototyping. For the users, their understanding and experience with technology was very diverse. Some had had previous experience with programming and/or the use of data base management software. Some had never touched a computer keyboard. The hands-on demonstration refined the knowledge of technological alternatives for some; for others, it was only their first exposure. As a result, there was a wide discrepancy among the users in the understanding of what was feasible, practical, and available.

As noted in the results, most of the staff agreed that there was a need to improve the management of information. Their understanding and definition of the need was a result of the interaction of two adoption factors **access to information** and **external pressure**. The external pressure which brought about the need for change was evident; MFP had been approved and new roles and responsibilities were indicated. However, the understanding of the ramifications of this plan varied from one staff member to another. Each staff member viewed the need for change from their own perspective. For example, senior administrators clearly understood that their reporting requirements would change because of the information that they received from meetings, directives, and other communications from Alberta Education. Other staff members were not always privy to this information. As a result, each staff member did not have the same background information; and therefore, did not understand the urgency or rationale for some decisions.

Implementation Factors

In Chapter Two, three groups of factors which affect the implementation phase of the change process were identified: change characteristics, organizational characteristics, and departmental characteristics. The influence of two of these groups was noted in this study. Each is discussed below.

The main factors identified in the implementation phase were **need, clarity, complexity,** and **product quality**, a group of four factors that Fullan refers to as the **characteristics of a change**. As noted in Chapter Four, not everyone felt that the current procedures were inadequate. The perceived need for change was not equivalent from one person to another. While some felt the need to change and improve the timeliness and quality of information was a first priority, others were satisfied with present systems.

For the thirteen people who participated in the hands-on demonstration, it was an educational experience which enabled them to understand the clarity, complexity, and quality of the proposed system directly. Although the demonstration time was limited, it still had an impact. Comments such as "only when you use it do you understand what is possible" indicated that regardless of previous efforts such as verbal explanations and presentations, some users still had to experience the information system to truly understand the concept. Other comments such as "we don't have a computer anyway ... I hate computers" were equally significant. Some users were resistant. They did not welcome a change; in fact, they were pleased that there were no plans to implement the final system.

For some users, the hands-on demonstration was the first time they had used a computer. For others, it was the first time they had used a DBMS. But regardless of their knowledge level, they used and evaluated the information system for themselves and developed their own understanding of the complexity and clarity of the system. Because the technological expertise of the users varied widely, their ability to evaluate the quality of FOCUS also varied. Nonetheless, they were all exposed to one example of a fourth generation language, and at a minimum, they all developed an awareness of the characteristics and capabilities of such a

product with respect to the management of information in the EROE context. The abstract discussions about needs, wants, and information management became concrete in the form of the information system and, as a result, the users were better able to define a personal relevance for such a change.

With respect to organizational characteristics affecting the implementation phase, the researcher noted the **support of senior administrators** as an important factor. The support of senior administrators was clear to the researcher throughout the study. Initially, however, the administration did not convey the implications of the project directly to the staff. As a result, some of the support staff were resistant because they were uncertain of how their job duties would be changed. No one had indicated which of them would be responsible for the system, and no one had indicated if training would be provided.

E. Recommendations

The following recommendations are based on the results and interpretations of the study. These recommendations do not reflect any limitations with respect to funds, staff, software, or hardware.

1. The ideal information system should be implemented.
2. The DBMS chosen should be a fourth generation language which supports prototyping, user defined menus, and English-like commands.
3. An information system developed using PC/FOCUS would be suitable for the data related to the jurisdiction level including school name and address.
4. A mainframe DBMS should be used to manage data related to teachers and courses.
5. The ability to upload and download files would be simplified if the same software were used on the mainframe computer and the microcomputer.
6. Prototyping should be the system development method used.
7. A person with the expertise needed to design and build an information system should be contracted externally.

8. A person should be appointed to manage the innovation: a change agent. This management should focus on involving all levels of the staff, incorporating their suggestions, and ensuring that the progress and implications of the implementation plan are conveyed to all.
9. The support staff should be responsible for the maintenance and operation of the system, but not the design and construction.
10. If support staff are expected to maintain and operate the system, they must be given the training required to learn the necessary skills.
11. All staff from the director to the support staff should be involved in the identification of needs.
12. An implementation plan must reflect those factors which influence the change process.

F. Conclusions

Based on the results of this study, the following conclusions can be drawn. These conclusions refer specifically to the context of the Edmonton Regional Office of Education, and there is no intention to suggest that they are generalizable to other situations.

Change is experienced from the perspective of each participant in a change not from the perspective of the person or persons initiating the change. Throughout the process, the researcher was constantly aware that each person involved in the study viewed the process of change from their own perspective. For example, even though the same external pressure was present, it was interpreted differently from person to person. Not everyone thought that the management of information needed to be improved. Most Performance Certifiers had different informational needs, yet most were unaware that the needs were so diverse. And a technological solution was considered obvious by some and unnecessary by others. Everyone did not espouse the same need for change. Change agents must recognize this fact, and take actions to try to resolve this inequity amongst the participants.

Senior administrators did not consider the perspective of others to be significant. The consultants and senior managers assumed that the support staff would play a major role in using the information system. Yet, they did not see the need to include the support staff in making decisions about the system. In fact, they were unaware of the concerns of the support staff and saw no reason to consult them. Change research indicates that anyone is likely to resist a change that he or she does not understand. In fact, this study noted that some of the support staff were indeed resistant to the innovation.

People who are expected to implement an innovation must have sufficient opportunity to understand the need or relevance for the change. People are the key ingredient in any change. If support staff are to be the major users of the system, they, too, must be involved in the initial stages so that they will understand the purpose of the change; realize how it will affect them; and have an opportunity to provide input. To avoid this clarification is to guarantee resistance. People must understand why, when, and how a change will occur.

Users are not a homogeneous group. Some staff enjoyed the prospect of learning a new system others were resistant. Users must be treated in individualistic ways. Their backgrounds and education are very diverse. For example, people who have been exposed to computer languages have a knowledge base that others do not have. This makes it easier for then to grasp the concept of commands and procedures. All staff cannot be expected to learn new systems at the same rate and should not be made to feel that they should. One training approach will not meet with the same response from all participants.

Senior management must take an active and visible role in the change process. In this way, staff will recognize that the change is endorsed and supported by senior management. Without this support, staff have no assurances that training, additional staff, or new supplies are forthcoming. Perceived ambivalence on the part of senior administrators is likely to have a deleterious affect on the proposed change.

Change theory provides a framework for an implementation plan. It serves as a guide for initiators of change by outlining the variables that influence the process and indicating why

they are important. In particular, the theory stresses the importance of people. Using this rationale, the researcher took specific actions to ensure that users would be involved as much as possible. For example, the researcher involved all levels of the staff in the identification of needs, the demonstration of the information system, and the solicitation of feedback. Although it may appear to be more expedient to ignore the reality of others, and to simply dictate what should be done, change theory provides the theoretical basis to understand why this approach is unlikely to work. Understanding change theory helps advocates to broaden their perspective, to avoid the assumption that all participants are equally aware of the benefits of a change, and to develop an implementation plan which is more likely to succeed.

Computerization and information management are not synonymous. One does not ensure the other. Computerization can only facilitate information management through quality technological alternatives such as FOCUS. In addition to technology, the management of information requires a thorough assessment of the user's needs and a process to translate these needs into an information system which provides the desired outputs.

Prototyping is experiential. Users learn from initial mistakes, refine specifications, and develop a better final product. Learning is inherent in the methodology. There is an opportunity to either dispel or confirm preconceived notions. Prototyping provides a viable alternative to the traditional development cycle. Using this method, the older cycle can be collapsed and made more responsive to the users needs. Thus many of the weaknesses associated with traditional systems development can be overcome.

Technology in and of itself does not solve problems. A computer and associated software are only tools designed for specific tasks. The selection of software and hardware products should be based on user requirements and user expertise. Good quality tools can augment but not supersede user skills. Training, planning, and understanding are still prerequisites.

The data base management software now available for microcomputers has a full range of features comparable to the features of mainframe software: PC/FOCUS and the

microcomputer environment have limitations such as storage capacity, response time, and maximum size of the data base. Despite these, the microcomputer software has all of the essential capabilities of the mainframe version. The quality and flexibility of report generation is identical. User menus can be written, and various security levels can be established to control user access. As a result, such products can enable a small office, such as the EROE, to manage a data base which only a few years ago would have been inconceivable.

G. Future Research

The study answered some questions, but it also raised others. These questions have implications for further research in the area of change theory, change agents, and motivation. Specifically, they include:

1. What factors would have influenced the likelihood of continuation? What would have happened if the study had been completed?
2. What skills should a change agent possess? Are there different outcomes if the change agent is inside or outside an organization? How does a change agent influence the outcomes of an innovation?
3. Why are some users resistant to change while others embrace it?
4. What impact does technology have on an organization? Will the role of support staff change?

H. Epilogue

Throughout this study, the researcher worked closely with the EROE staff over a period of four months. She was accepted and treated as a member of the staff. As a result, the staff were very candid with the researcher and indicated their attitudes and reactions to technology and change. Based on these observations, some personal perceptions from the researcher's perspective are related below.

Within the context of this study, the researcher was a change agent. As such, she recognized that one of the key tasks for an agent of change is to convince people of the need for and importance of a change. People comprise the most important component in an innovation. Throughout the change process, a change agent must continually inform the participants, accept suggestions and modifications, and reassess implementation activities long after the change agent would like to finalize the process. The ability to be flexible and sensitive to the users' needs, and yet remain faithful to the intent of the innovation, is the challenge for any agent of change.

All of the users did not share the researcher's enthusiasm for technology. Motherhood statements such as "this is the electronic age," or "computerization is inevitable" were not only meaningless but provocative to some. Such statements provide no valid rationale for those who have no understanding of technology. Instead, the change agent must consider change an educational process and provide sufficient learning time and appropriate learning experiences to ensure that participants begin to comprehend what will happen, how it will happen, and perhaps more importantly, why it will happen.

Software recommendations are subjective and are usually based on the experience and/or motives of the reviewers. Simply because a software product is referred to as powerful, flexible or user-friendly, does not necessarily mean that it is easy to use or appropriate for every situation. Rather than selecting software based on the recommendations of others, choices should be based on the needs and expertise of the users.

As a final point, the researcher noted that the need for guidance and direction with respect to the use of computerized systems is imperative. In any work environment, people have specific job duties and responsibilities. It is unrealistic to expect that they can adopt and implement new procedures without help. Although computers and associated software have become easier to use, and although there are some people who have had experience with computers and various software products, there are few who can install and operationalize computer technology to its fullest capacity without assistance. People need help to plan the

transition from a manual system to an electronic system. They need help to understand the rationale and purpose of any proposed system. And they need training so that they can develop the skills needed to operate a system. Initiators of change have an obligation to provide assistance and direction in each of these areas in order to facilitate the successful implementation of an innovation. If people are expected to alter the way in which they currently perform their job duties, it is natural for them to need guidance; if such guidance is omitted, it is possible for them to become resisters of the change.

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Appendix A: Glossary

central processing unit (CPU): the part of the computer containing the circuits that interpret and execute instructions to the computer.

CMS: Conversational Monitor System is an operating system (see below) that operates in an IBM/370 (a mainframe computer).

CMS file: a file residing in a mainframe environment which uses CMS. This file would adhere to CMS format and naming conventions.

computer: an electronic device for performing high-speed arithmetic and logic operations, and composed of five basic components - arithmetic logic unit, control unit, input and output devices, and memory. The three general classifications of computers are microcomputer, minicompuuter, and mainframe computer whose differences depend on the type of processor, size of memory, and input/output devices used. (Because of rapid advances in technology, the boundaries between these classifications are not clearly defined.)

data: a formalized representation of facts or concepts suitable for communication, interpretation, or processing by people or by automated means.

data base: a collection of data, as defined by a user or system; a file of interrelated data stored together to serve one or more users; or the total set of relevant data available to a computer or its users.

data base management system: a collection of software that handles the storage, retrieval, and updating of records in a data base. A data base management system controls redundancy of records and provides the security, integrity, and data independence of a data base.

disk operating system (DOS): a software program responsible for the housekeeping and communication functions needed to get the disk storage system and the main computer unit to work together. In addition, DOS is usually responsible for communications between the computer and other peripheral devices.

DOS file: a file residing in a microcomputer environment which uses the DOS operating system. This file would adhere to DOS format and naming conventions.

download: the electronic transfer of files from a mainframe computer environment to a microcomputer environment.

file: a group of related items treated as a single unit. The items may consist of text, data or program instructions.

file extension: the second part of a file name. Although the file extension could be almost any combination of letters, specific extensions are usually used because they have particlar meaning for the user and for programs. The operating system and language used combine to define file extensions. For example, a file named "test.fex" would contain a set of dialogue manager instructions for PC/FOCUS (see below) in a DOS environment. A file named "test focexec" would contain a set of dialogue manager instructions for FOCUS in a CMS environment.

floppy disk: an inexpensive type of memory storage that uses flexible or "floppy" disks (or diskettes) made of a material similar to magnetic tapes. They are the most common form of storage used for a microcomputer.

FOCUS: a fourth generation language with strong data base management capabilities. It operates in a mainframe environment. (Appendix B contains more details.)

FOCUS file: a file which can be accessed directly by FOCUS (or PC/FOCUS). The file does not have to be converted as it is already written in a format that is recognized by FOCUS (or PC/FOCUS).

format: the definition of the arrangement and location of data within a larger storage unit.

hard disk: disk storage that uses rigid rather than flexible disks as the storage medium.

IBM PC/XT: the model name of a microcomputer produced by IBM. The standard IBM PC/XT comes with an internal 10 megabyte hard disk and one floppy disk drive.

interface: the connection between two devices, such as the computer and the keyboard, or the conventions for passing control and data between programs.

K or KB: an abbreviation for a kilobyte, which is 1,024 bytes. (This is about half of a normal typewritten page, so 64K would be enough memory to store about 32 typed pages.)

mainframe computer: this term has changed its meaning over time. Firstly, it referred to the framework of a computer which contained the arithmetic and logic unit; then it was used to refer to the central processor itself; and now it tends to be used to refer to large computers in order to distinguish them from microcomputers, microprocessors, and minicomputers.

menu driven: software that guides the microcomputer user by presenting a number of alternate functions from which to choose.

microcomputer: a small computing machine which is built around a microprocessor and typically serves one user at a time. (See computer.)

microprocessor: a silicon chip containing the circuitry for the central processing unit of a computer.

operating system: a collection of software programs that work together and make it possible for a computer to operate. These programs accomplish such tasks as input-output between the computer and its peripherals, or accepting and interpreting information entered through the keyboard. CMS is an example of an operating system.

PC DOS: the IBM version of DOS.

PC/FOCUS: a fourth generation language with strong data base management capabilities. It operates in a microcomputer environment. (Appendix B contains more details.)

peripheral: a device that attaches to the computer, such as a disk drive, monitor, or printer.

stand alone: a device that is self-contained, not dependent on another unit for memory or processing.

upload: the electronic transfer of files from a microcomputer environment to a mainframe computer environment.

Appendix B: FOCUS Specifications

In the User's Manual, FOCUS is described as "a comprehensive information control system" (FOCUS user's Manual, 1984:1-01). Information Builders Inc. introduced FOCUS for mainframes in May 1976. It was well received; and sold well. In May of 1983, they introduced the "pre-release version" of PC/FOCUS. A year later, the "production version" of PC/FOCUS was released.

In software reviews, these products are often referred to as data base management systems. Although this is true, this label is not comprehensive enough. They are more accurately called fourth generation languages. Together they provide a way to link the mainframe and the microcomputer environments.

A. Capabilities and Features

The major features of FOCUS and PC/FOCUS include the following:

1. Report Generation:

   A subset of the commands introduced by the TABLE command which generate reports and enable the user to perform calculations, set formats, and define selection and validation criteria.

2. File Maintenance:

   A subset of the commands introduced by the MODIFY command which add, delete, and change records.

3. Interactive Edit:

   A subset of the commands introduced by the SCAN command which allow the user to browse and edit the file interactively.

4. Financial Modelling Language (FML):

   This facility allows the preparation of 'row oriented' reports.

5. Interactive Data Entry Language (FIDEL):

   This facility allows the design and implementation of full screen interactive data entry.

6. Dialogue Manager:

   Procedures which are run repetitively or require a response from the user can be catalogued and executed on demand. These procedures are stored in FOCEXEC (or .FEX in PC/FOCUS) files.

7. User Structured Language

   This facility enables the user to change the language and vocabulary of FOCUS to suit specific applications.

These features are independent of each other in their functions; however, they maintain common commands and syntax from one feature to another. Therefore, the user can become proficient in one feature without the necessity of learning them all. Yet, the commonalities amongst the features make it easier to learn each new one.

Although the microcomputer version is naturally slower, and unable to handle extremely large files, it is nonetheless very powerful. In fact, PC/FOCUS has some additional features which enhance the the mainframe version:

1. FileTalk:

   A built-in utility that allows the rapid definition of file descriptions through a menu selection.

2. TableTalk:

   A built-in utility that allows the rapid definition of reports through menu selection.

3. LINK:

   A menu-driven communications software that manages the micro/mainframe link and file transfer facilities.

4. TED:

   An editor built into the system which manages any sequential file. (Although system editors are a routine feature in the mainframe environment, such editors are not usually built into software available on microcomputers. It is for this reason that TED is considered an enhancement to the PC version.) Other editors, such as EDLIN distributed

with DOS, could be used; however, TED provides some obvious advantages:

a. TED uses the full-screen facilities of the system so that by moving the cursor to any position the user can insert, delete, and replace characters.

b. TED can be called from within PC/FOCUS by issuing the command TED m:file.ext.

c. TED is similar to editors available on mainframe FOCUS; thus making it an easy to understand feature for mainframe users (PC Guide to Operations, 1984:6-01).

B. File Structure

The basic building blocks of a FOCUS file are the data elements or fields. A group of fields which are related to one another compose a segment. One or more segments (usually related to each other) compose a file. Figure B.1 illustrates an example of the file structure of three files. The MFP file has one segment called *info*, the SINFO file has two segments called *school* and *juris*, and the JINFO file has three segments called *juris, staff,* and *info*.

The relationship of fields to segments and segments to files is defined in the **master file description**. The name and type of each field, each segment, and the file, itself, are listed in the master file. For example, the master file listing in Figure B.2 defines a file called JINFO. Among other things, this file definition indicates that:

1. The data file this master description file refers to is a FOCUS file (SUFFIX = FOC).
2. The file has three segments called *juris, staff,* and *info*.
3. The file has 15 fields and only one of these, JCODE, is indexed (FIELDTYPE = I).
4. The field called *jname* can also be referred to as *jn*.

The file description is a map which enables the computer to locate the required data. Once the map or defintion is complete, it is possible to build FOCUS files, or this map can be used to access external (non-FOCUS) files.

FOCUS is a hierarchical database management system. The parental relationships of the segments defined in the file description define the hierarchy. However, this hierarchy is not

Figure B.1

FOCUS File Structure

(Public Jurisdictions Only)

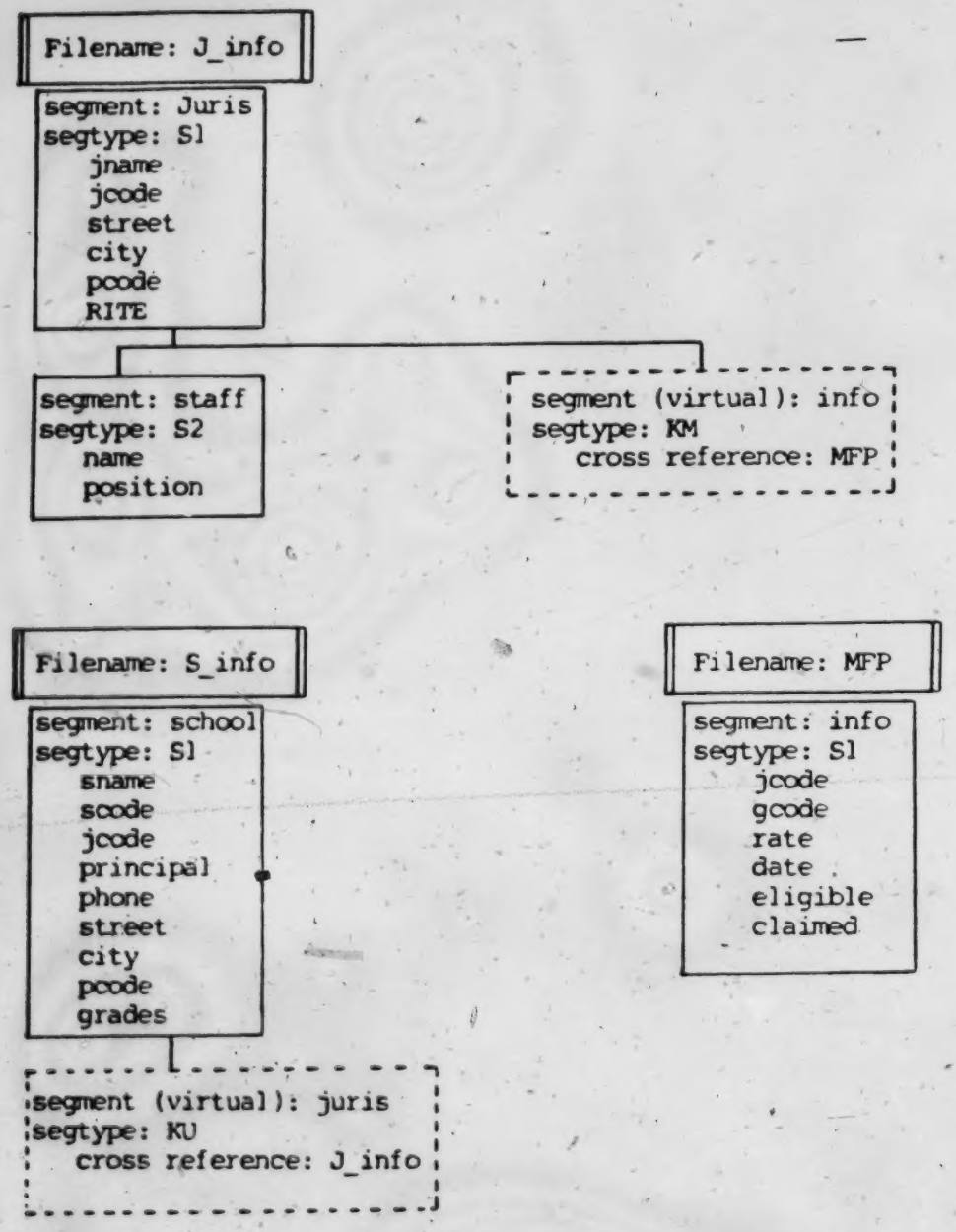


Figure B.2

Master File Description

```
JINFO  MASTER  A1  F  80  TRUNC=80  SIZE=14  LINE=0  COL=1  ALT=0
==== * * * TOP OF FILE * * *
==== FILENAME=JINFO, SUFFIX=FOC,$
==== SEGMENT=JURIS, SEGTYPE=S2,$
==== FIELD=JNAME, ALIAS=JN, USAGE=A30, ACTUAL=A30,$
==== FIELD=JCODE, ALIAS=JC, USAGE=I4, ACTUAL=I4, FIELDTYPE=I,$
==== FIELD=STREET, ALIAS=ST, USAGE=A30, ACTUAL=A30,$
==== FIELD=CITY, ALIAS=C, USAGE=A20, ACTUAL=A20,$
==== FIELD=PCODE, ALIAS=PCODE, USAGE=A7, ACTUAL=A7,$
==== FIELD=PHONE, ALIAS=PH, USAGE=A8, ACTUAL=A8,$
==== FIELD=RITE, ALIAS=RITE, USAGE=A8, ACTUAL=A8,$
==== SEGMENT=STAFF, PARENT=JURIS,$
==== FIELD=NAME, ALIAS=N, USAGE=A22, ACTUAL=A22,$
==== FIELD=POSITION, ALIAS=POS, USAGE=A32, ACTUAL=A32,$
==== SEGMENT=INFO, PARENT=JURIS, SEGTYPE=KM,
==== CRFILE=MFP, CRKEY=JCODE,$
==== * * * END OF FILE * * *
```

as rigid as it might appear. For example, Figure B.1 illustrates three files with a total of six segments. However, there are actually only four segments which are cross-referenced to create three "views" of these interrelated files. Segments from one file can be "cross-referenced" by another file.

In Figure B.1, the segment called *info* is defined in a file called MFP (CRFILE = MFP). JINFO cross-references this segment to MFP by using a key field (CRKEY = JCODE). This provides a very flexible file structure. Cross-referencing allows more than one hierarchical relationship to be defined using the same segments. These alternate definitions are referred to as different "views." The "view" can be defined statically by a master file definition; or dynamically by using the JOIN command at execution. Each method has advantages and disadvantages.

1. Static Cross-Reference:
    a. only needs to be defined once,
    b. always active,
    c. selected cross-references segments can be described, others omitted,
    d. the user does not need to be aware of where segments are located,
    e. makes it easy to update a file when only the pertinent material is there,
    f. provides a way to save storage for multiply occurring elements.
    g. must be planned in advance.
2. Dynamic Cross-Reference:
    a. does not have to be preplanned,
    b. does not take any file space,
    c. can be added or dropped as needed,
    d. requires more execution time because it must process the file sequentially to find the required elements,
    e. requires the user to issue and understand the JOIN command.

A particular application would determine which of the above were advantages and which were

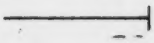
disadvantages.

C. FOCUS Environment

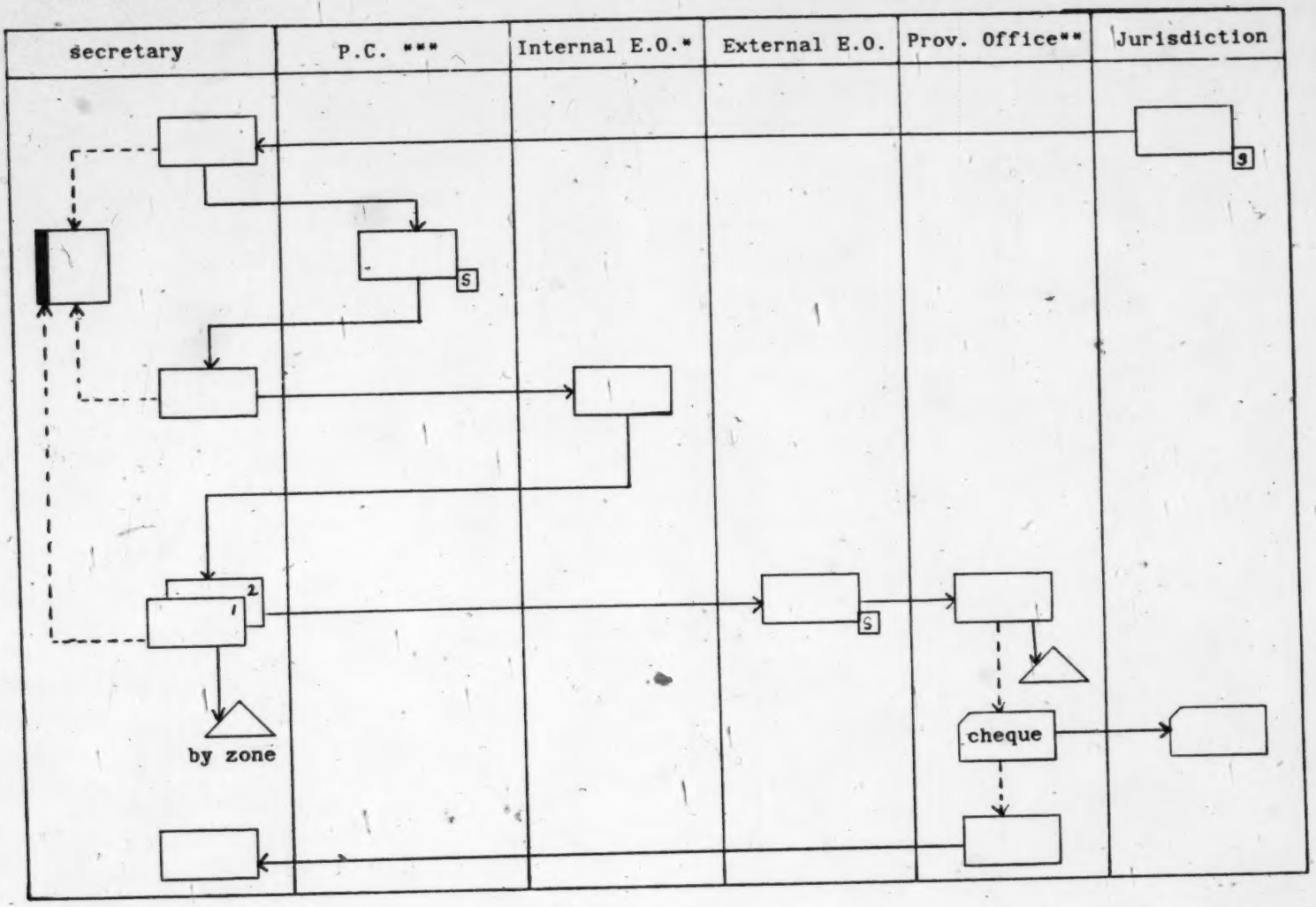
"FOCUS can be used on a variety of operating systems and communication monitors. There is virtually no difference between the use of FOCUS itself on different systems, but different environments require different protocols for naming and cataloguing FOCUS files" (FOCUS User's Manual, 1984:1-04). In this study, FOCUS was used on an IBM 370 (mainframe computer) using the CMS operating system, and PC/FOCUS was used on an IBM/XT (microcomputer) using the PC-DOS operating system.

Appendix C: Document Flowcharts

Standard Flowchart Symbols

Symbol	Description/Comments
	document
	flow of document
	information from document is used in next step
	dead end
	permanent file
	initials or signs
	book or ledger

GRANT FORM: EXTERNAL

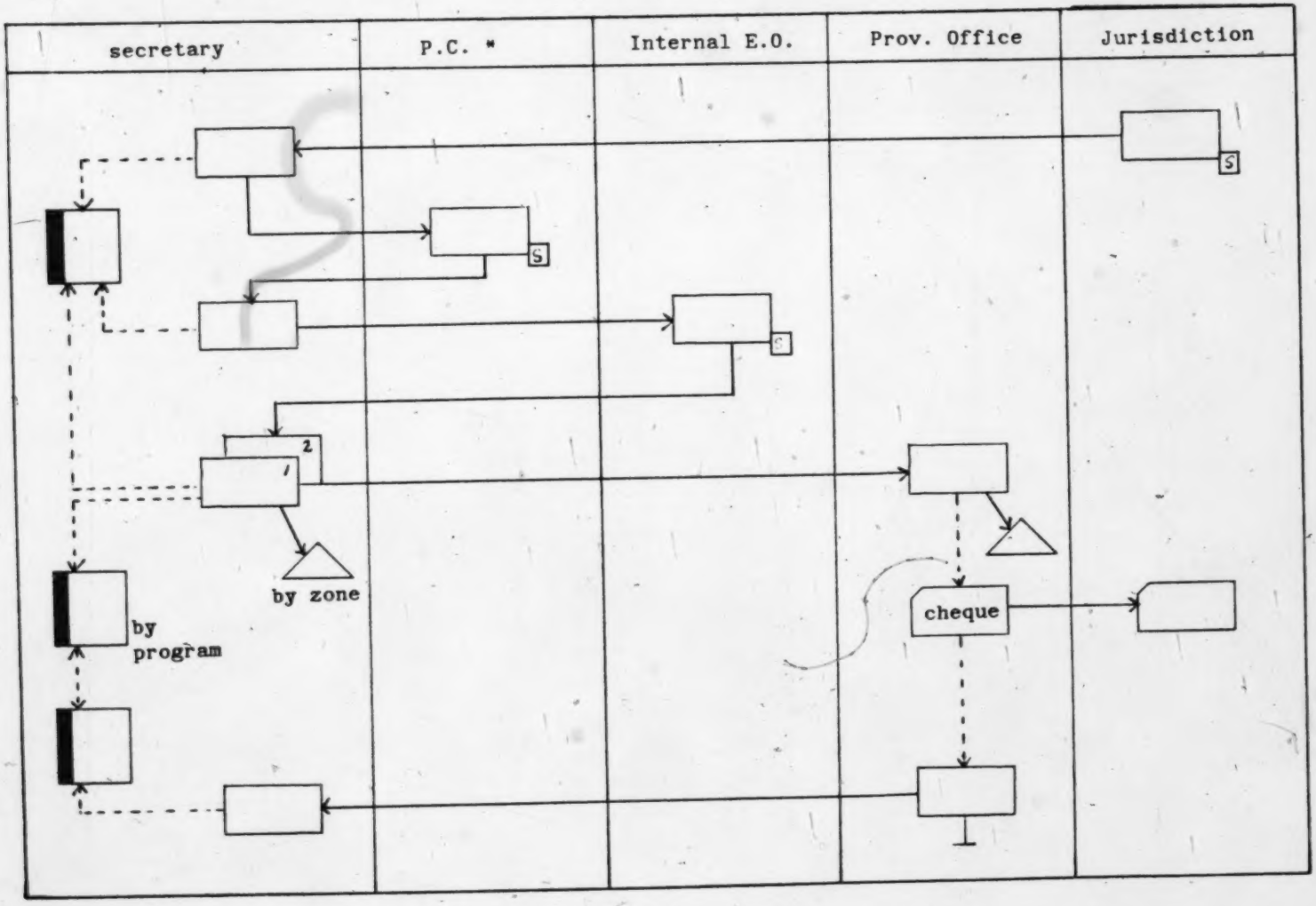


*** Performance Certifier

*E.O. = Expenditure Officer

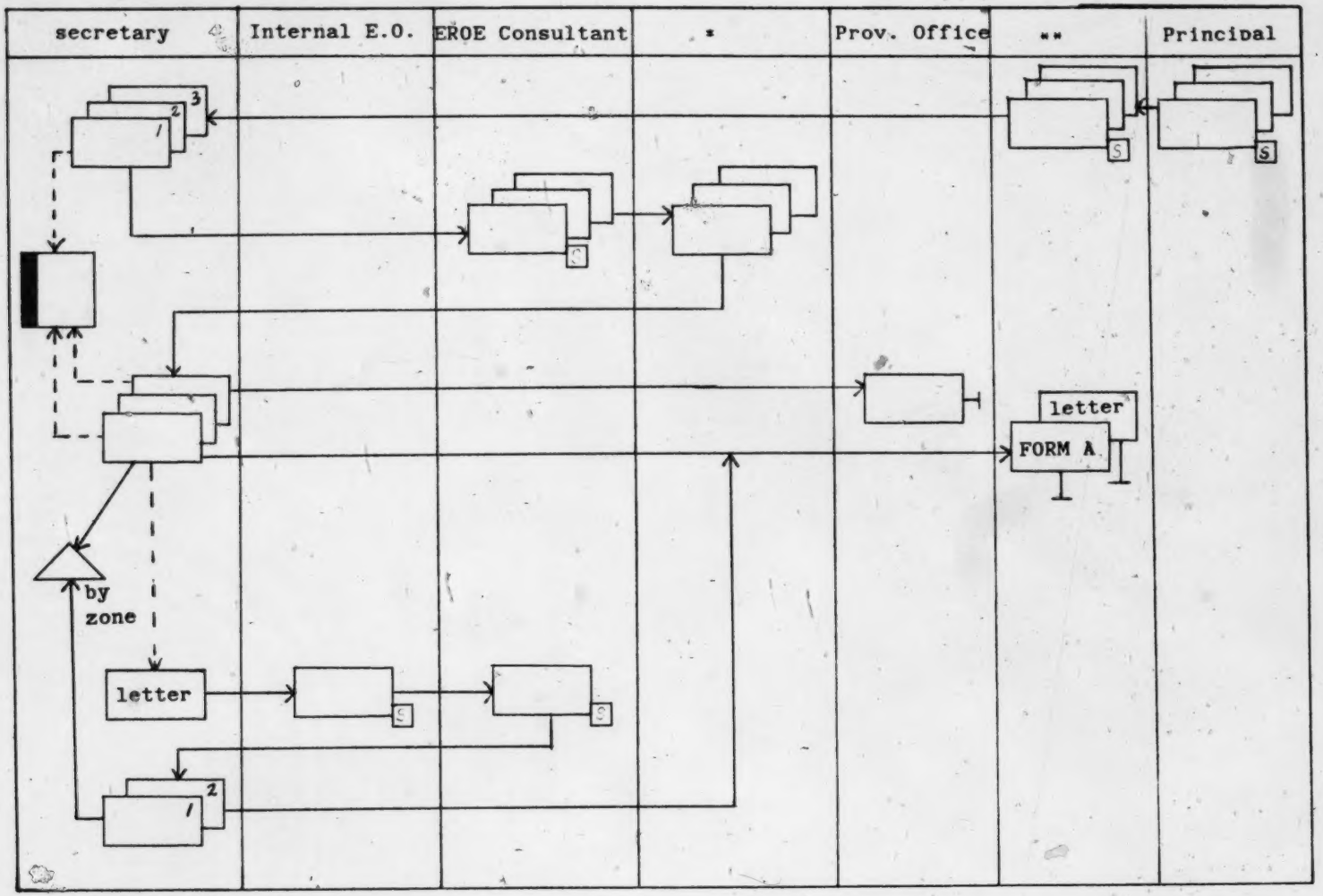
** Prov. Office = Provincial Office of Education

GRANT FORM: INTERNAL



* Performance Certifier

FORM A: JUNIOR/SENIOR HIGH

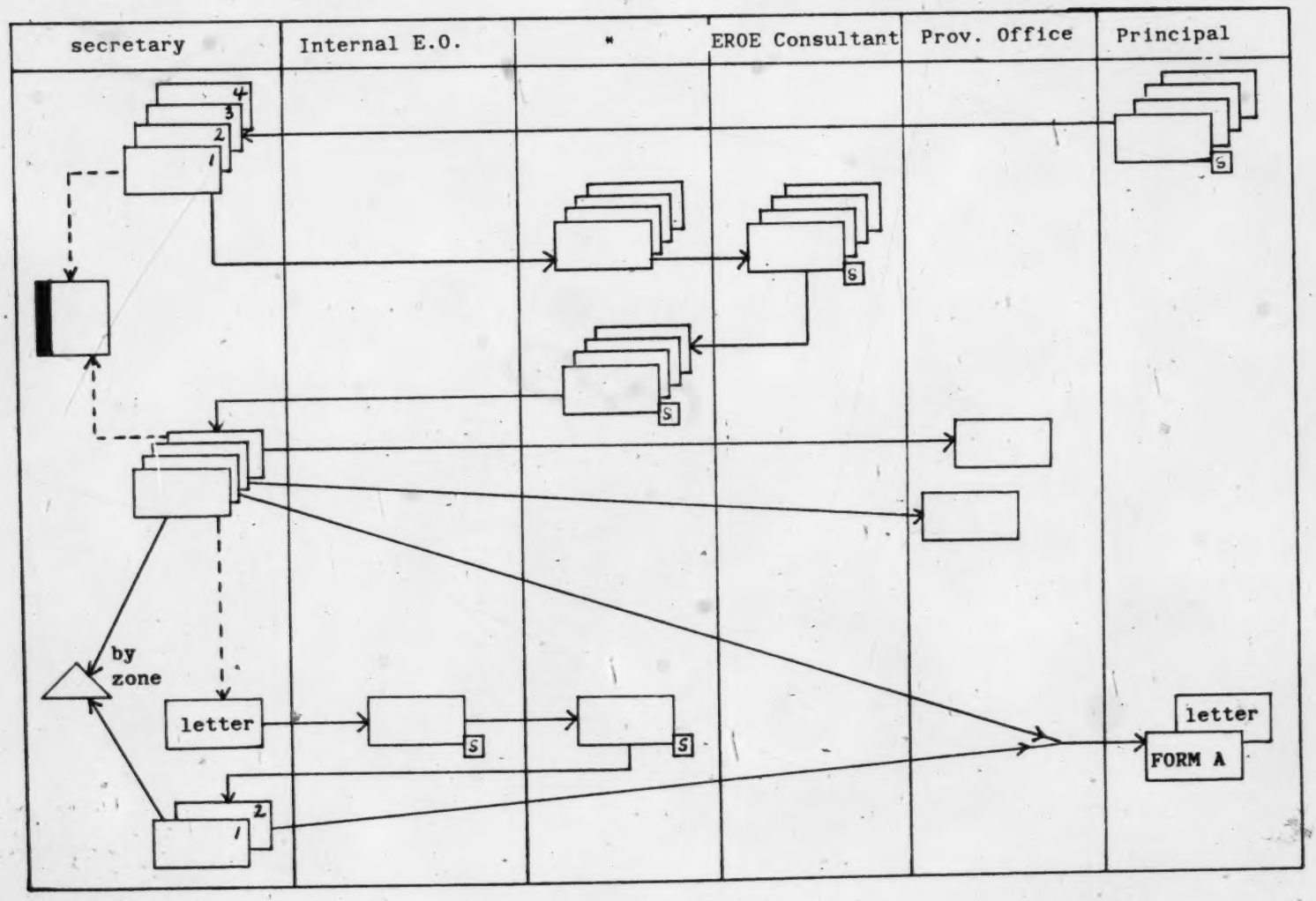


** Superintendent

* Business Ed. consultant checks Business Ed. courses

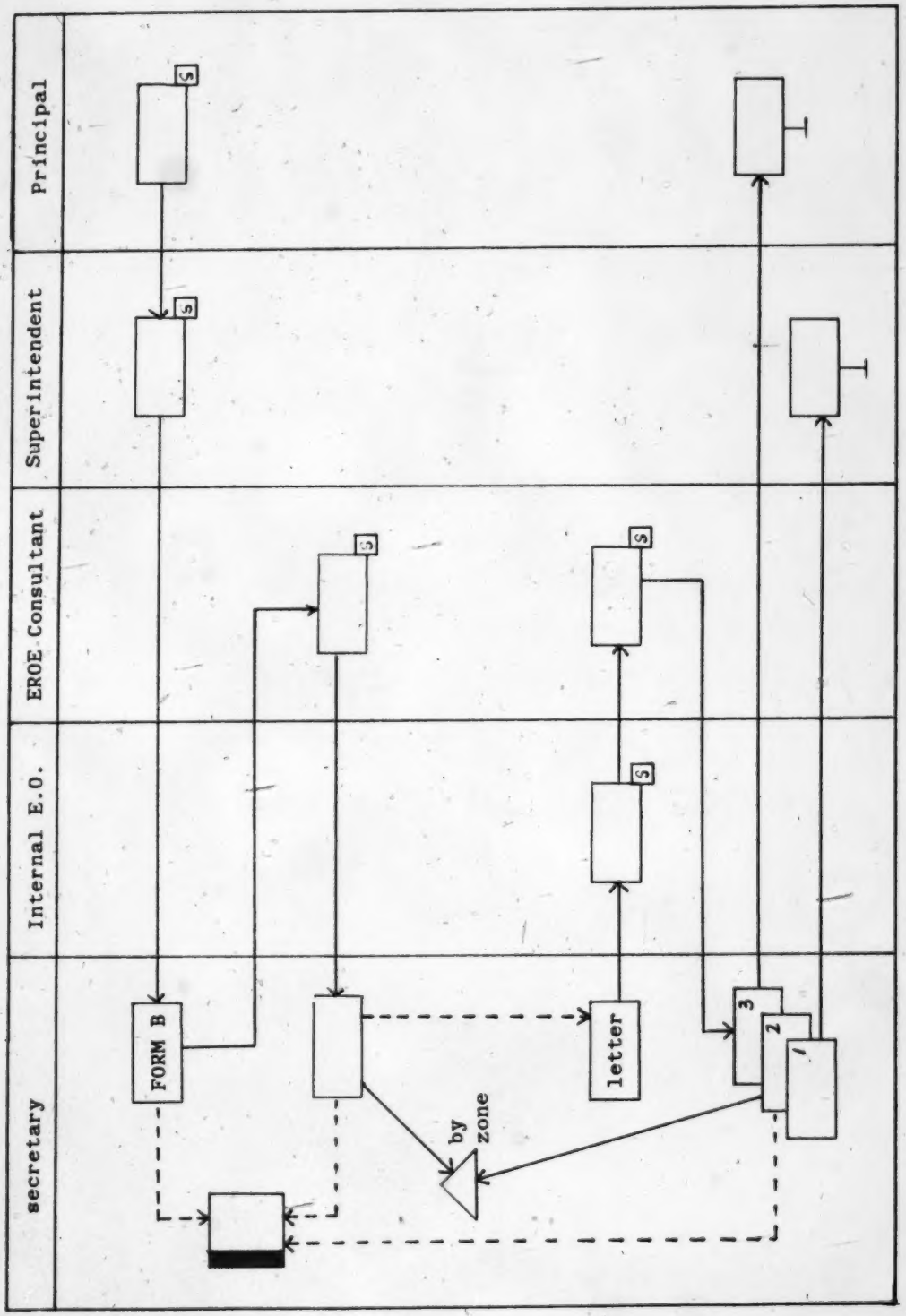
Voc. Ed. consultant checks Voc. Ed. courses

FORM A: PRIVATE JUNIOR/SENIOR HIGH

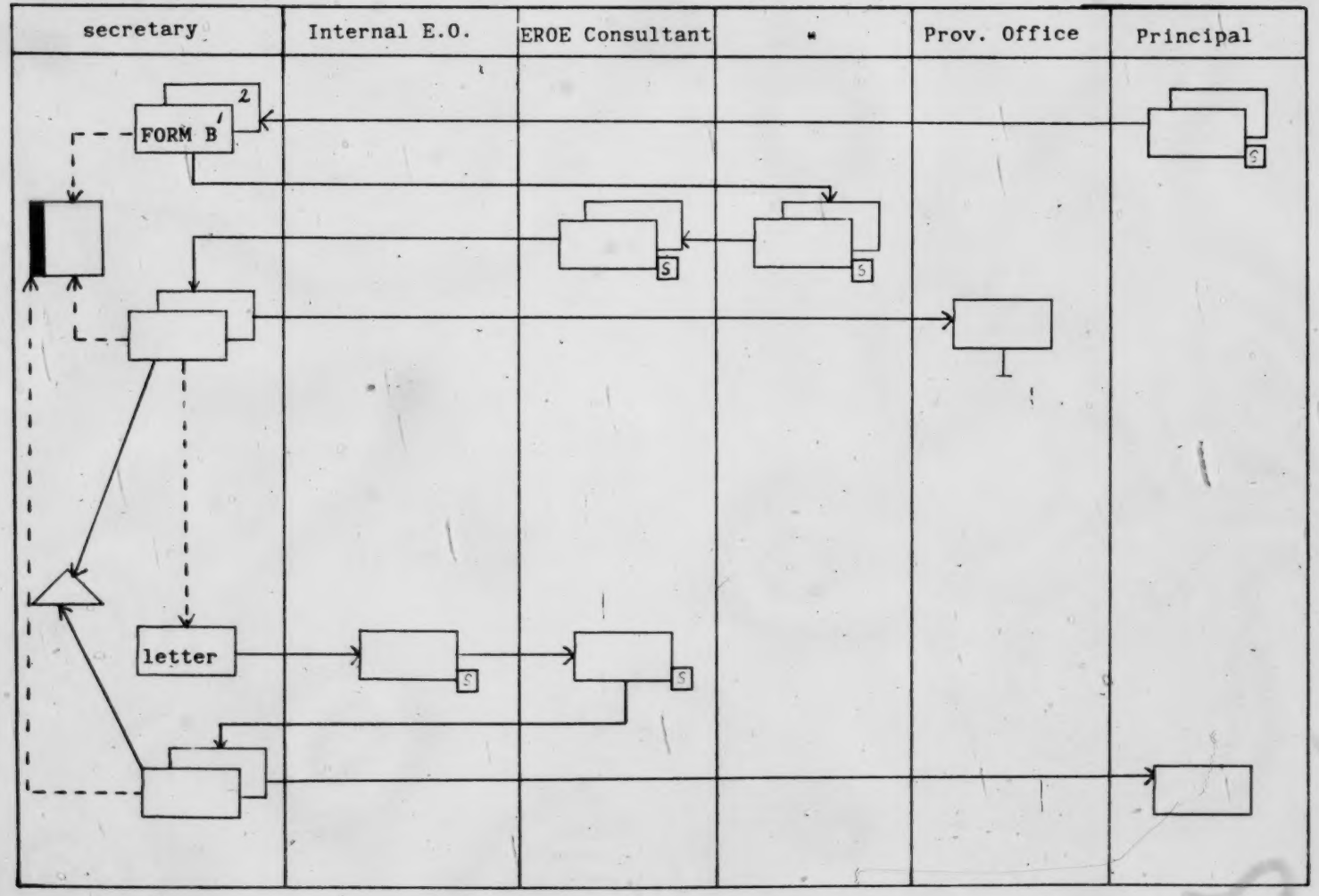


* EROE Consultant responsible for this private school

FORM B: ELEMENTARY



FORM B: PRIVATE ELEMENTARY



*EROE Consultant responsible for this private school

Appendix D: Ledger Sheets

	Extension Gr.I-XII	Extension Adult	Extension Spec. Ed.	E.O.F. Elementary	E.O.F. Compensatory	French Language	Second Language	E.S.L.	Spec. Ed.	Institutional Support	Gifted Program	Teacher In-Service	Academic Occupational	Vocational Education
Date Received														
Given to Performance Certifier														
Received from Performance Certifier														
Given to Expenditure Officer														
Approved/Checked														
Sent to Grants														
Date Received														
Given to Performance Certifier														
Received from Performance Certifier														
Given to Expenditure Officer														
Approved/Checked														
Sent to Grants														

PROGRAM: _____ DATE: _____

PERFORMANCE CERTIFIER: _____ EXPENDITURE OFFICER: _____

JURISDICTION	DATE PROCESSED	RATE $	MULTIPLIED BY FACTOR	AMOUNT CLAIMED	AMOUNT APPROVED	RUNNING TOTAL

Appendix E: Questionnaires

Questionnaire given before development 115

Questionnaire given after development 117

Information System Questionnaire

Please check those questions or reports which you feel would be of use to you in your work. Place an X beside those items which you feel would be of little or no use.

Private Schools

___ List schools by category, giving name of school, principal and phone.
___ List schools by zone.
Other suggestions:

Check the information you would like to see on a Private School data sheet:

___ name
___ principal
___ address
___ category
___ zone
___ enrolment
___ number of teachers
___ special program
___ affiliation
___ approved grades
___ grades presently offered
other suggestions

Would you be likely to use a data sheet on Private Schools? _____

Jurisdiction Information

___ For a chosen jurisdiction, list the central office personnel and their positions.
___ List all schools alphabetically by zone.
___ List all schools alphabetically by jurisdiction.
___ List all schools alphabetically by type (Junior High, Elementary).
___ List all schools with an enrolment less than 100.
Other suggestions:

Check the information you would like to see on a regular school data sheet:

___ name
___ principal
___ school code
___ jurisdiction code
___ jurisdiction name
___ phone
___ address
___ enrolment
___ number of teachers
___ comments (e.g. Voc. Ed. approved)
other suggestions:

Would you be likely to use a data sheet for regular schools? _____

Program Grants

___ List the total of all funds approved to date.
___ List the total funds paid to a chosen jurisdiction for all seven grants to date.
___ Provide a grand total for the above i.e. a total of the seven program grants paid to the chosen jurisdiction.
___ List the total funds approved by program. This list would list each jurisdiction and the amount paid for a particular grant.
___ Provide a grand total for the above.
Other suggestions:

FOCUS Questionnaire

Have you used a computer language before? _____

If yes, list the name(s) of the language(s). _____

Section One Comment on the following system components and/or characteristics:

	Mainframe	Micro
response time:		
screen display:		
keyboard:		
reports:		
data elements available:		

Section Two Using FOCUS:

You have used two methods of generating reports: menu, and FOCUS commands.

Which method did you prefer? Why?

Comment on the menu method:

Comment on the FOCUS command method:

Possible considerations:

- ease of use
- flexibility
- ease of understanding
- suitablility of output

Appendix F: Dialogue Manager Procedures

The following menu would appear on the screen.

```
>            REPORT MENU
-------------------------------------------------------------

1.  LIST SCHOOLS BY ZONE: BOTH, 2, OR 3.
2.  LIST SCHOOLS BY JURISDICTION: FOR ONE OR ALL.
3.  LIST PRINCIPALS WITH THE SCHOOL NAME AND PHONE NUMBER.
4.  LIST SUPERINTENDENTS BY JURISDICTION.
5.  LIST CENTRAL OFFICE STAFF FOR A JURISDICTION.
6.  LIST ALL JURISDICTIONS ALPHABETICALLY.
7.  LIST PROGRAM GRANT TOTALS BY PROGRAM.
8.  LIST PROGRAM GRANT TOTALS BY JURISDICTION.
9.  EXIT MENU (RETURN TO FOCUS).

ENTER YOUR CHOICE:>9
>>
```

The FOCUS dialogue manager procedures which generate this menu are listed on the next three pages.

```
-RETRY
-TYPE            REPORT MENU
-TYPE ------------------------------------------------------------
-TYPE0 1.  LIST SCHOOLS BY ZONE: BOTH, 2, OR 3.
-TYPE 2.  LIST SCHOOLS BY JURISDICTION: FOR ONE OR ALL.
-TYPE 3.  LIST PRINCIPALS WITH THE SCHOOL NAME AND PHONE NUMBER.
-TYPE 4.  LIST SUPERINTENDENTS BY JURISDICTION.
-TYPE 5.  LIST CENTRAL OFFICE STAFF FOR A JURISDICTION.
-TYPE 6.  LIST ALL JURISDICTIONS ALPHABETICALLY.
-TYPE 7.  LIST PROGRAM GRANT TOTALS BY PROGRAM.
-TYPE 8.  LIST PROGRAM GRANT TOTALS BY JURISDICTION.
-TYPE 9.  EXIT MENU (RETURN TO FOCUS).
-TYPE
-PROMPT &NUMBER. ENTER YOUR CHOICE:.
-IF &NUMBER EQ 1 GOTO ONE;
-IF &NUMBER EQ 2 GOTO TWO;
-IF &NUMBER EQ 3 GOTO THREE;
-IF &NUMBER EQ 4 GOTO FOUR;
-IF &NUMBER EQ 5 GOTO FIVE;
-IF &NUMBER EQ 6 GOTO SIX;
-IF &NUMBER EQ 7 GOTO SEVEN;
-IF &NUMBER EQ 8 GOTO EIGHT;
-IF &NUMBER EQ 9 GOTO NINE;

-ONE
-INCLUDE ONE
-GOTO RETRY

-TWO
-INCLUDE TWO
-GOTO RETRY

-THREE
-INCLUDE THREE
-GOTO RETRY

-FOUR
-INCLUDE FOUR
-GOTO RETRY

-FIVE
-INCLUDE FIVE
-GOTO RETRY

-SIX
-INCLUDE SIX
-GOTO RETRY

-SEVEN
-INCLUDE SEVEN
-GOTO RETRY

-EIGHT
-INCLUDE EIGHT
-GOTO RETRY

-NINE
-EXIT
```

```
-SET &ECHO=ON;
-PROMPT &ZONE.(3,2,BOTH).ENTER 2, 3, OR THE WORD BOTH:.
-IF &ZONE EQ 'BOTH' GOTO ALL1;
TABLE FILE SINFO
"OPERATING SCHOOLS IN ZONE &ZONE"
PRINT PH
BY JN
BY SN
IF Z EQ &ZONE
END
-RUN


-TYPE ENTER THE JURISDICTION CODE FOR THE ONE YOU WANT.
-PROMPT &JC.OR ENTER THE WORD ALL:.
-IF &JC EQ 'ALL' GOTO ALL;
TABLE FILE SINFO
"OPERATING SCHOOLS FOR JURISDICTION &JC"
PRINT PH
BY JN
BY SN
IF JC EQ &JC
END
-RUN
-GOTO RETURN

-ALL
TABLE FILE SINFO
"OPERATING SCHOOLS FOR ALL JURISDICTIONS"
PRINT PH
BY JN
BY SN
END
-RUN

-RETURN


-SET &ECHO=ON;
TABLE FILE SINFO
PRINT SN PH
BY PRIN
BY JC
END
-RUN


-SET &ECHO=ON;
TABLE FILE JINFO
PRINT JN PH RITE
BY NAME
IF POS EQ SUPERINTENDENT
END
-RUN
```

```
-SET &ECHO=ON;
-PROMPT &CENCODE.ENTER THE JURISDICTION CODE THAT YOU WANT:.
TABLE FILE JINFO
PRINT NAME POS
BY JN
IF JC EQ &CENCODE
END
-RUN


-SET &ECHO=ON;
TABLE FILE JINFO
PRINT JC C ST PCODE PH
BY JN
END
-RUN


-SET &ECHO=ON;
-PROMPT &GC.ENTER THE PROGRAM CODE THAT YOU WANT:.
TABLE FILE JINFO
PRINT JC AND CL AND COLUMN-TOTAL
BY JN
IF GC EQ &GC
END
-RUN


-SET &ECHO=ON;
-TYPE DO YOU WANT ONE JURISDICTION OR ALL JURISDICTIONS?
-TYPE
-PROMPT &ONE.ENTER THE JURISDICTION CODE OR THE WORD ALL:.
-IF &ONE EQ 'ALL' GOTO ALL2;
TABLE FILE JINFO
PRINT CL AND COLUMN-TOTAL
BY JN
BY GC
IF JC EQ &ONE
END
-RUN
-GOTO RETURN

-ALL2
TABLE FILE JINFO
PRINT CL
BY JN
BY GC
ON JN SUB-TOTAL
ON JN PAGE-BREAK
END
-RUN

-RETURN
```

Appendix G: FOCUS Documentation

Introduction

This documentation was written as a reference guide and user manual for the Edmonton regional office information system. Two parallel systems were built: one on a mainframe computer; and one on a microcomputer. These systems consist of data elements which are contained in fields stored on the respective computer. The management of these data elements is accomplished by using FOCUS.

FOCUS is a computer language which allows the user to manage and manipulate data and generate reports. Valid FOCUS commands may be entered when the FOCUS prompt: > is on the screen. However, it is <u>not</u> necessary to know <u>any</u> FOCUS commands to perform the operations explained in this manual. This manual explains a menu-driven system which will allow the user to issue reports. The report menu and the operations available are explained in the following pages.

Mainframe:Operating the System

Signing On

1. Enter the following: cenvm1.

   (This is to indicate your location is central.)

2. Hit the enter key.

3. Enter the following: logon edps01.

   (Your user id is edps01.)

4. Hit the enter key.

5. Enter the password: psrs.

6. Hit the enter key.

7. Hit the enter key again and wait.

   You will see some messages on the screen and the word **RUNNING** will appear in the lower right corner of the screen.

   You have now successfully entered the CMS operating system, and you are ready to run the program **FOCUS**.

Entering FOCUS

1. Enter the following: focusenv.

   This will set up the FOCUS environment.

2. Enter the following: focusacc.

   The word FOCUS will appear in large letters on the screen. Notice that the word **MORE...** now appears in the lower right corner of the screen. Whenever this occurs, hold down the **alt key** and press the **clear key**. Release them both.

The word more indicates that CMS needs more room for the display. It does not scroll forward automatically, but rather the user must do it manually.

You have now successfully entered the FOCUS environment. This is indicated by a message and the prompt: > . You are ready to enter FOCUS commands.

Report Menu

If you want to view and use the Report Menu, enter the following command and follow the instructions that appear on the screen.

Enter: ex report.

For a further explanation of these choices, see the Report Menu section.

Signing Off

1. When you have the FOCUS prompt: > on the screen, enter: fin.

   This will allow you to leave FOCUS and enter CMS.

2. Enter: log.

   This will allow you to leave CMS and complete the signoff procedure.

Micro: Operating the System

Signing On and Entering FOCUS

When you turn the machine on, the title Fixed Disk Organizer will appear. It is not necessary to enter the time and date, you can simply hit return twice and a menu will appear.

1. Hit the F7 key.

2. In response to the question do you want to leave DOS, enter the letter Y. The screen will clear and this prompt will appear: C>.

3. Enter the following command: path e:\karen;d:\myfocus;

   (This command must be typed exactly.)

4. Hit the return key.

5. Enter cd e:\karen.

6. Hit the return key.

7. Enter d:.

8. Hit the return key.

9. Enter cd\myfocus.

10. Put the FOCUS activator disk in the A drive.

11. Enter focus.

You have now successfully entered the FOCUS environment. This is indicated by a message and the prompt: >>. You are ready to enter FOCUS commands.

Report Menu

If you want to view and use the Report Menu, enter the following command, and follow the instructions that appear on the screen.

Enter: ex report.

For a further explanation of these choices, see the Report Menu section.

Signing Off

1. When you have the FOCUS prompt: >> on the screen, enter: fin.

   This will allow you to leave FOCUS and enter DOS. You could enter any DOS commands, or run another application. If you are finished, you can shut the machine off.

Report Menu

This file contains data related to public schools.

1. List schools by zone: both, 2, or 3.
2. List schools by jurisdiction: for one or all.
3. List principals with school name and phone number.
4. List superintendents by jurisdiction.
5. List central office staff for a jurisdiction.
6. List all jurisdictions alphabetically.
7. List and total program grants by program.
8. List and total program grants by jurisdiction.c
9. Exit menu (return to FOCUS).

These choices produce reports either at the terminal or on paper. Each report title is self explanatory.

Grant Codes

1. L2: Languages other than English or French.
2. L3: English as a second language.
3. E1: Board Extension.
4. S1: Special Ed. block grant.
5. V1: Academic occupational.
6. V2: Vocational education.
7. ECS2: ECS program grant.

Data Elements Available: Sinfo File

NAME	DESCRIPTION
sname	name of the school
scode	school code
jcode	jurisdiction code
principal	principal's name
phone	
street	street address, rural route, or box number
city	city, town, or village
pcode	postal code
grades	grades taught at school

Data Elements Available: J Info File

NAME	DESCRIPTION
jname	name of the jurisdiction
jcode	jurisdiction code
street	street address, rural route, or box number
city	city, town, or village
pcode	postal code
phone	
RITE	government phone line
name	name of central office staff member
position	position or title of staff member

Data Elements Available: MFP File

NAME	DESCRIPTION
jcode	jurisdiction code
gcode	code for special program grants
rate	dollar value per eligible grant unit
date	date grant was processed
eligible	eligible grant unit eg. students, course hr.
claimed	amount claimed by jurisdiction